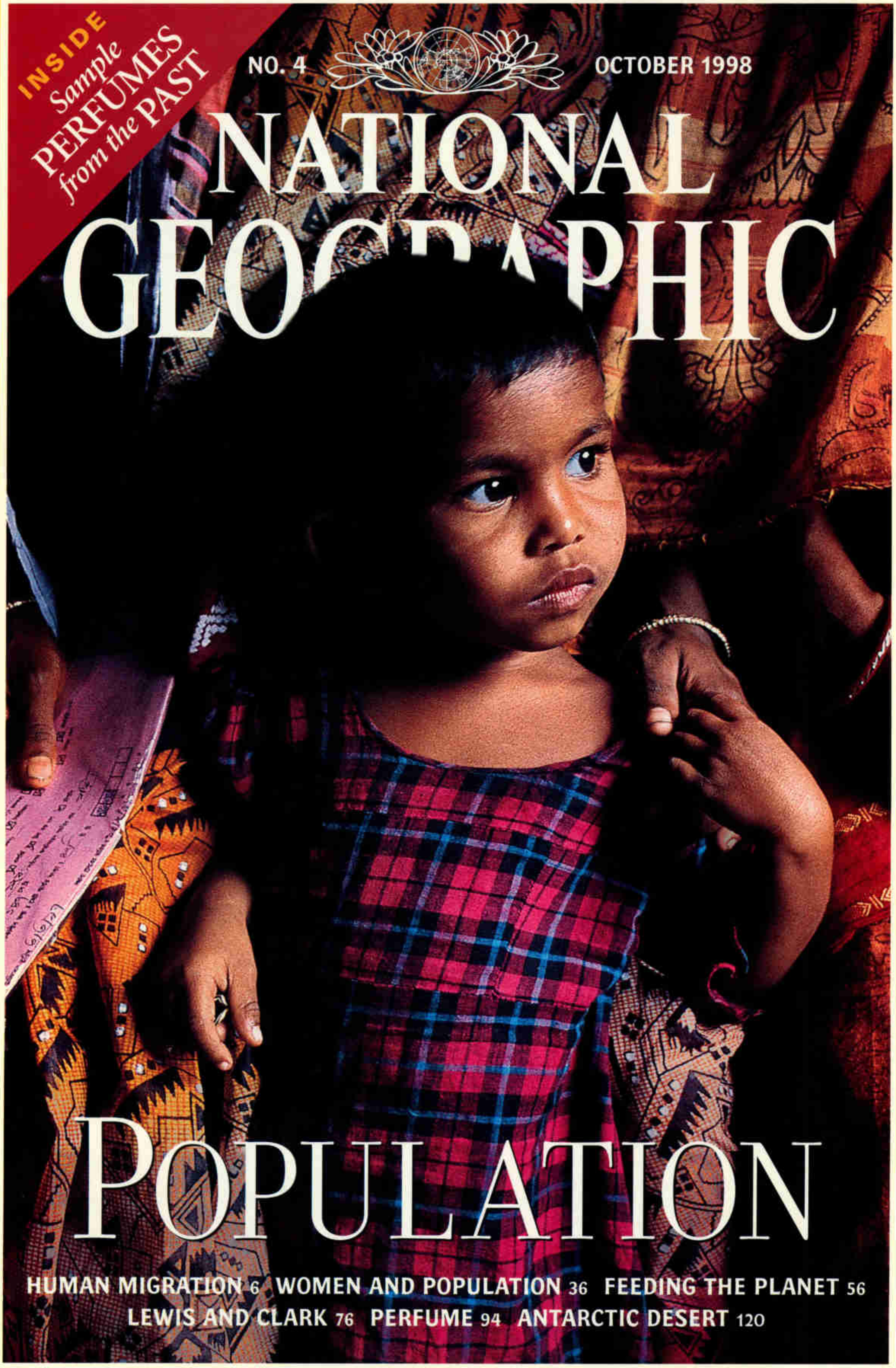
MILLENNIUM SUPPLEMENT: POPULATION

INSIDE
Sample PERFUMES *from the* PAST

NO. 4 OCTOBER 1998

NATIONAL GEOGRAPHIC



POPULATION

HUMAN MIGRATION 6 WOMEN AND POPULATION 36 FEEDING THE PLANET 56
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OFFICIAL JOURNAL OF THE NATIONAL GEOGRAPHIC SOCIETY WASHINGTON, D.C.

Supplement to NATIONAL GEOGRAPHIC, October 1998

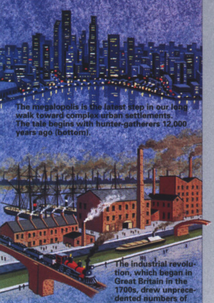
MILLENNIUM IN MAPS

POPULATION

NATIONAL GEOGRAPHIC SOCIETY

As the 21st century approaches, the news on global population is mixed. The fear from decades past, that an exploding population would quickly outstrip Earth's capacity to support it, has subsided. Falling birthrates have slowed population growth, and there's a good chance that the world's population will level off in the next century. But that will be with several billion more people, and the planet's population—5.9 billion and growing by more than 80 million a year—has almost doubled since 1960. Catastrophe may or may not arrive, says population expert Joel E. Cohen, but one thing is certain: "What we get as we increase our population are increasingly difficult choices." The environmental and economic trade-offs we already face are sure to intensify.

2000 NATIONAL GEOGRAPHIC



The megalopolis is the latest step in our long walk toward complex urban settlements. The tale begins with hunter-gatherers 12,000 years ago (bottom).

The industrial revolution, which began in Great Britain in the 1700s, drew unprecedented numbers of people into cities.

Urban life was insular in medieval Europe, where cities centered around agriculture and defense.

Thirteenth-century Hangzhou, China, dazzled explorer Marco Polo.

More people meant more power for Rome, history's first million-person city, around 2,000 years ago.

With the polis, or city-state, Greece introduced participatory government to urban life. Greeks also excelled in city planning.

Unlike agricultural villages, early cities such as Mesopotamia's Ur, founded in the fourth millennium B.C., had food surpluses that allowed people to do nonagricultural work.

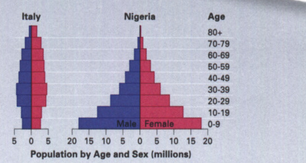
Permanent agricultural villages arose in the Middle East around 8,000 B.C.

The Rise of Cities

Until the last ice age ended 12,000 years ago, people lived as hunters and gatherers, constantly moving in pursuit of food. The planet supported perhaps ten million people. The advent of agriculture changed everything. The land it took to feed one hunter-gatherer could feed scores of farmers. In time, improved agriculture productivity freed people to do other work—crafts, trade, government—that fostered the growth of cities.

A World Growing Larger and Less Equal

Every three years the world's population grows by roughly the size of the United States, the third largest country, and 98 percent of that growth is in developing nations. With more than 30 of them on course to double in size in the next 30 years, Earth's profile promises to change dramatically. Pakistan, which had fewer than 40 million people in 1950, is expected to top the U.S. for third position, behind India and China, by 2050. Nigeria, on track to triple its population, is projected to become the fifth largest. Such fast population growth keeps developing countries from escaping poverty, because economic growth can't match pace. As it is, between 1960 and 1994 the disparity in per capita income between the richest and poorest fifth of the world's nations widened from 30 to1 to 78 to 1.

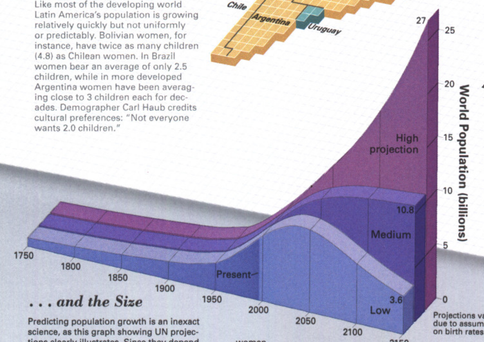


The Shape of Things to Come . . .

Fast-growing nations like Nigeria have increasingly large numbers reaching childbearing age. Such populations keep growing even as individual women bear fewer children. Italy has relatively few young people because its women average only 1.2 children each. Without immigration, its population will shrink.

With one of the highest population growth rates in the industrialized world, the United States stands apart from Europe and Japan, which are projected to shrink in coming years. If American women continue averaging about two children each and immigration continues at its present pace (immigration accounts for one-third of the country's growth), the U.S. will add 120 million people in the next 50 years, the same number it has added in the past 50.

Like most of the developing world Latin America's population is growing relatively quickly but not uniformly or predictably. Bolivian women, for instance, have twice as many children (4.8) as Chilean women. In Brazil women bear an average of only 2.5 children, while in more developed Argentina women have been averaging close to 3 children each for decades. Demographer Carl Haub credits cultural preferences: "Not everyone wants 2.0 children."



. . . and the Size

Predicting population growth is an inexact science, as this graph showing UN projections clearly illustrates. Since they depend largely on an unpredictable variable—how many children will be born—the projections vary widely. The UN now estimates that world population will be between 3.6 and 27 billion by 2150, and the difference between the two projections is only one child per woman. If fertility rates continue to drop until women have about two children each—the medium-range projection—the population will stabilize at 10.8 billion. If the average becomes 2.6 children, the population will more than quadruple to 27 billion; if it falls to 1.6, the total will drop to 3.6 billion.

Projections vary due to assumptions on birth rates.

Europe and Africa are going in opposite directions fast. With the highest birthrate of any continent, Africa has grown from 470 million people in 1980 to 763 million in 1998, and it is projected to grow to two billion by 2050. Women in sub-Saharan Africa bear an average of 6 children each; European women average 1.4 children, too few to replenish the population. Europe is projected to shrink 12 percent by 2050, from 728 million to 638 million. "I'd hate to be selling a house in Europe 15 years from now," says one demographer.

Though its one-child-per-family policy hasn't been absolute, China's growth slowdown has been dramatic. Its fertility rate plummeted from 6.5 children per woman in 1968 to 2.3 in 1980; it's now 1.8. Even so, China's 1.2 billion population exceeds that of the entire industrialized world.

In 1947, the year of its independence, India had 350 million people. Fifty years later it's about to reach one billion. Though India—the first developing country to adopt a family-planning policy—has slowed its growth rate, it is still projected to become the world's most populous country by 2050.

From a population of 21 million in 1950 the Philippines is poised to reach 131 million by 2050, more than either Russia or Japan. The Philippines' fast growth is only one factor; Russia and Japan are projected to shrink 22 percent and 13 percent, respectively, in the next 50 years.

Population and Growth

This cartogram depicts each country relative to its population size. Each square represents one million people. Colors represent growth rates, excluding migration.

3% and above
2-2.9%
1-1.9%
0-.9%
Population loss

Design: Charles W. Berry. Research: Mary Kate Cannistra, Peter A. Jaloszyn. Edit: Maureen J. Flynn, David B. Miller. Production: Glenn C. Calhoun, Neal J. Edwards, Dianne C. Hunt, Micki A. Laws, John T. Sebastian. Text: Glenn Hodges, author; Alice J. Dunn, Kerry O'Toole, researchers. Art by Pierre Mion

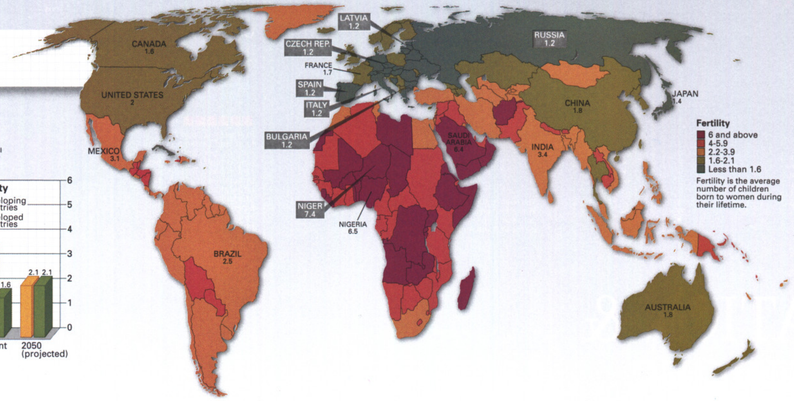
Consultants: Kimberly E. Baugh, Christopher D. Elvidge, NOAA National Geophysical Data Center; Joel E. Cohen, Rockefeller and Columbia Universities; Peter H. Gleick, Pacific Institute for Studies in Development, Environment, and Security; Michael J. Grillot, Energy Information Administration, DOE; Charles F. Gritzner, South Dakota State University; Carl Haub, Population Reference Bureau; Daniel Hillel, University of Massachusetts; Paul C. Sutton, University of California, Santa Barbara; United Nations Population Division; U.S. Census Bureau; World Resources Institute

FERTILITY

Smaller Families

In a population that's neither growing nor shrinking and has no migration, couples will average two children each, or enough to replace themselves. Of the world's 192 nations, 67 now have fertility rates at or below replacement level. Because of the youthfulness of the developing world—one-third of which is under 15—even if the entire globe had reached replacement levels in 1995, the population would still grow by two-thirds before leveling off. Though the global fertility rate is still well above replacement level, the average fertility rate in developing countries has dropped from more than 6 children per woman in 1950 to 3.3 in 1998 and is still falling. More than half of all developing countries have policies to reduce fertility rates.

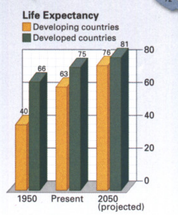




LIFE EXPECTANCY

Longer Lives

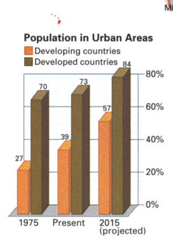
The 20th century's population explosion is as much a success story as it is a problem. Between A.D. 1000 and 1750 famine, disease, and war held population growth to 0.1 percent a year. Life expectancy was low, infant mortality was high, and families compensated by having many children. In the 19th and early 20th centuries medical advances, public sanitation, and better living standards gradually reduced the Western world's death rates, and birthrates followed suit. After World War II the West introduced vaccines and other public health measures to developing regions. Death rates plummeted; birthrates stayed high. Between 1950 and 1998 the developing world's average life expectancy rose from 40 to 63 years, and world population more than doubled.



URBANIZATION

Closer Quarters

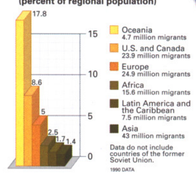
Forty-five percent of the world's people now live in urban areas, up from roughly a third in 1960. Urbanization is occurring fastest in developing countries; since 1950 their urban populations have more than doubled to 39 percent. The world now has 41 cities with five million or more people, and 23 more are expected to join the ranks by 2015. All but 11 of the total will be in the developing world. City dwellers tend to have higher standards of living and better health than rural residents, but when cities grow as fast as many are in the developing world, their economies and infrastructures are hard-pressed to keep up. Small cities don't necessarily have better living conditions than big ones, since many countries funnel much of their resources to their largest cities.

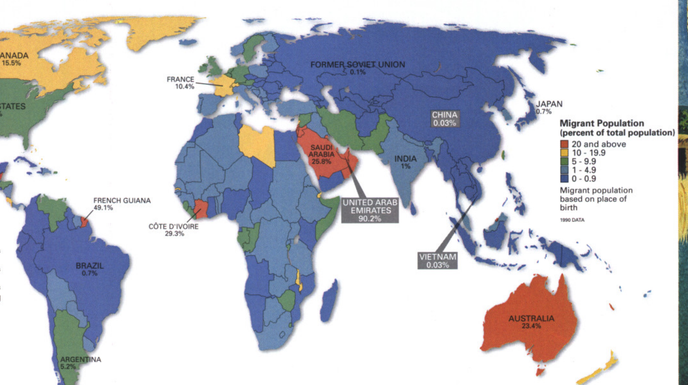


WORLD MIGRATION

Distant Homes

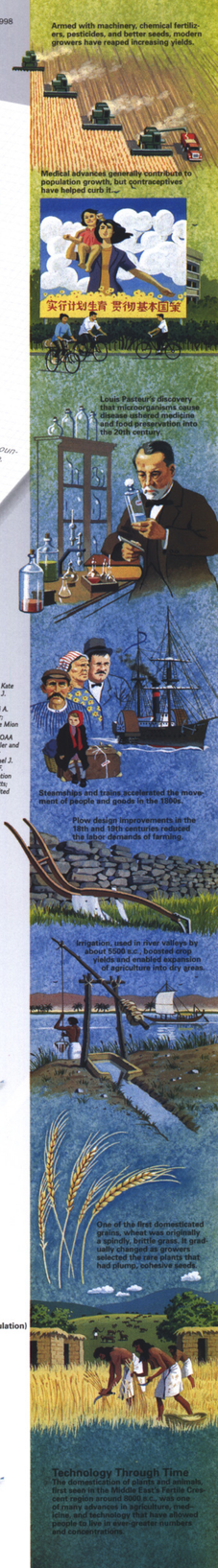
Two percent of the world's people—some 120 million—lived outside their country of birth in 1990. People migrate for many reasons, including escaping persecution or war, rejoining family, or finding jobs. Those who migrate for economic reasons may not always be met with open arms, but they usually go where their labor is needed. In the case of some oil-rich Mideast countries, where migrants make up most of the workforce, that labor is essential. While Oceania tops the chart (right) with the highest percentage of migrants, it has only one-tenth the number of migrants that live in Asia. Migratory pressures are likely to increase in the next 30 years. One reason: The industrialized world's native labor pool is projected to shrink as the developing world's workforce doubles.





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Armed with machinery, chemical fertilizers, pesticides, and better seeds, modern growers have reaped increasing yields.

Medical advances generally contribute to population growth, but contraceptives have helped curb it—

实行计划生育 贯彻基本国策

Louis Pasteur's discovery that microorganisms cause disease ushered medicine and food preservation into the 20th century.

Steamships and trains accelerated the movement of people and goods in the 1800s.

Plow design improvements in the 18th and 19th centuries reduced the labor demands of farming.

Irrigation, used in river valleys by about 5000 B.C., boosted crop yields and enabled expansion of agriculture into dry areas.

One of the first domesticated grains, wheat was originally a spindly, brittle grass. It gradually changed as growers selected the rare plants that had plump, cohesive seeds.

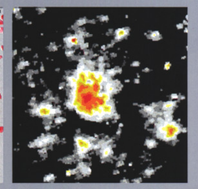
Technology Through Time

The domestication of plants and animals, first seen in the Middle East's Fertile Crescent region around 9000 B.C., was one of many advances in agriculture, medicine, and technology that have allowed people to live in ever-greater numbers and concentrations.

Supplement to NATIONAL GEOGRAPHIC, October 1998

PAUL C. SUTTON, UNIVERSITY OF CALIFORNIA, SANTA BARBARA





Population Density (people per square mile)
7,700
1,900
400
90
No data

Light Level
High
Low

Night lights . . .

Nighttime satellite imagery provides a snapshot of both population density and energy consumption. This Mexico City example shows that population density (far left) and light emissions (left) correspond with each other fairly well. Such a parallel has limits though. Northern India is one of the planet's most densely populated regions, but it is also one of the poorest. Its light output does not even begin to compare to, say, Florida's. Nonetheless, satellite imagery can be a valuable supplement to census data, which in many developing countries is not reliable.

Oil production makes Prudhoe Bay look more peopled than it is. Its population in 1990: 47.

Prudhoe Bay

Settlement hasn't strayed far from the Trans-Siberian Railroad, traced by the string of lights east of Moscow.

Yellow spots mark natural gas flares burning at oil wells in Siberia, the Persian Gulf, off Nigeria, and elsewhere.

. . . black holes

Asia's eastern coast demonstrates how carefully nighttime satellite images must be interpreted. Compared with its much more industrialized southern neighbor, North Korea looks nearly unpopulated, though its people number some 22 million. The Korea Strait, between South Korea and Japan, has only a few island residents but is one of the brightest spots on the globe, thanks to Japan's mammoth fishing fleets. Nighttime imagery has been available since the 1970s, but only recently have technological gains made it possible to filter out clouds and create global images.



United States and Canada

2.5
$27,100
357
5.6
2
22

Combined, the U.S. and Canada use about twice as much energy per capita as Europeans, 10 times more than Asians, and 20 times more than Africans. The U.S. alone uses more than one-fourth of the world's oil. By one estimate, the average American will in a lifetime consume 62,000 pounds of animal products, 55,000 pounds of plant foods, 770 tons of minerals, and the energy equivalent of 4,000 barrels of petroleum.

Today's sprawling cities are meeting at the edges, forming huge urban corridors. Example: Washington to Boston.

Europe

0.5
$13,710
144
2.5
1.1
9.4

Since communism's collapse in 1989 energy consumption and carbon dioxide emissions have declined in Eastern Europe. The transition to a market economy slowed production, inefficient factories were closed, and energy-saving improvements were made.

The bright lights of the squid-fishing fleets in the Sea of Japan appear blue-green.

Asia

51
$2,490
33
1.4
0.4
2.5

As Asia's economy grows, so do its consumption levels. China's economy alone grew tenfold between 1953 and 1989, and its energy consumption grew 18-fold. China's use of coal, which emits more carbon dioxide than any other fuel, is projected to double by 2015. Already, China is second only to the U.S. in CO_2 emissions; by 2020 it's likely to be first. Developing Asian nations still use far less energy per capita than industrialized nations, but the gap is narrowing.

Puerto Rico is one of the most densely populated islands in the Caribbean, with more than 1,100 people per square mile.

Six months of fires, shown in brown, cut across the African savanna and pepper Southeast Asia and Australia.

Lifeline of an arid nation, the Nile River's importance to Egypt is clear from its luminous banks.

Lights of the World

This satellite image is a composite of cloud-free observations made over a six-month period (October 1994 through March 1995). To avoid reflections from the moon on water and clouds, images from the dark half of each lunar cycle were used.

- Fires
- Fishing fleets
- Human settlement lights
- Natural gas flares

Composite image: NOAA, National Geophysical Data Center. Raw satellite data: US Air Force Defense Meteorological Satellite Program.

Regional Indicators

Data are shown for United Nations' designated regions.

- **Population increase** (symbol equals two million people annually)
- **Income per capita** ($2,500 in U.S. dollars)
- **Energy consumption** (50 million Btu per person annually)
- **Fresh water availability** (one million gallons per person annually)
- **Cropland** (half an acre per person)
- **Carbon dioxide emissions** (two tons per person annually)

Latin America and the Caribbean

7.5
$3,710
49
9.6
0.9
3

One-fourth of the world's renewable water resources are in Latin America. Hydroelectric power provides more than 60 percent of its electricity, so the region produces a low proportion of industrial carbon dioxide. However, fires from deforestation in Brazil and elsewhere continue to cough up significant CO_2 emissions.

Pursuing squid with bright lights, shown in blue-green, fishing fleets line the edge of the continental shelf off Argentina.

Africa

20
$650
15
2.2
0.7
1.2

The fastest growing region on Earth, Africa faces the most serious potential shortages of food and water. Political instability and the lack of infrastructure make distribution of both farm equipment and food supplies unreliable. Six of the world's 18 water-scarce nations are in Africa, and six more African countries are projected to join that group by 2025.

The relative affluence of the Witwatersrand area around Johannesburg shows up clearly in South Africa.

Oceania

0.5
$15,430
181
19
4.5
12

In Australia, New Zealand, and Oceania's island nations, per capita cropland is high because the region has a Tokyo-size population in a land area larger than the contiguous United States. Just 6 percent of Australia, which accounts for the bulk of Oceania's landmass and population, is arable, though it still grows enough to export most of its leading grain crop, wheat.

POPULATION & RESOURCES

Produced by National Geographic Maps for National Geographic Magazine

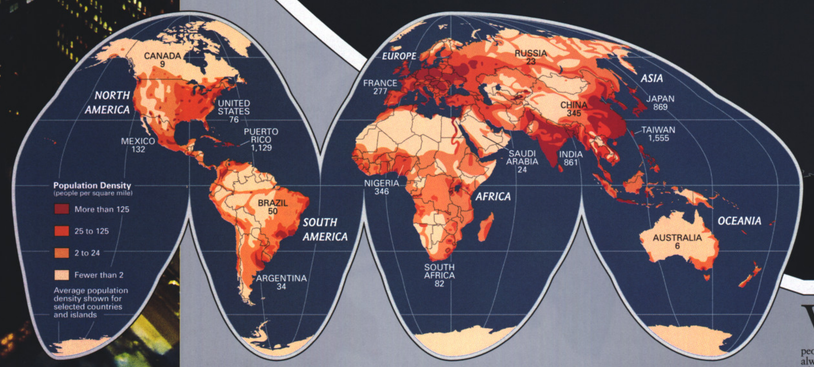
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Washington, D.C., October 1998

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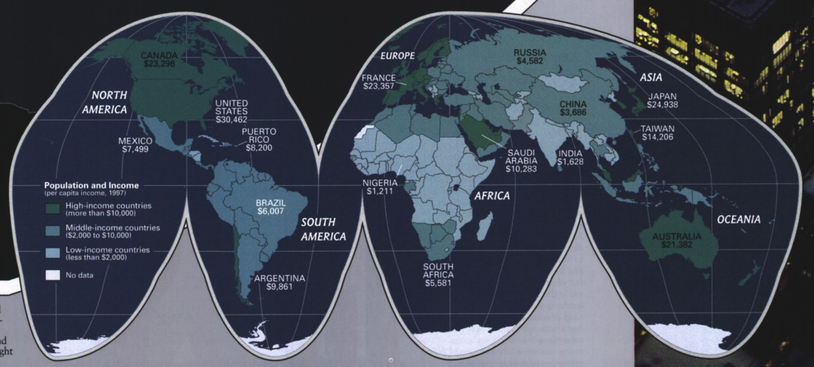
SCALE 1:54,109,440 or 1 INCH = 854 MILES AT THE EQUATOR

STATUTE MILES 0 500 1000 1500
KILOMETERS 0 500 1000 1500



Areas of the world shown in red at left may have the least elbowroom, but densely populated areas are not necessarily overpopulated. The key is whether people have access to resources.

The map at right shows that the world's wealth is spread as unevenly as its people. More than 1.3 billion live on less than one dollar a day.



VIEW OF CHICAGO ALONG THE SIDE PANELS WAS PROVIDED BY MIKE MITCHELL/CLOUD, INC.

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When Earth had but a tiny fraction of its current population—as long ago as ancient Babylon—people understood the dangers of overpopulation. But how many people is too many? The answer to that question has always proved elusive. Thirty years ago, after decades of unprecedented growth, some experts were certain that the planet was on the verge of widespread famine and resource depletion. Then the green revolution multiplied agricultural yields, while metals and fossil fuels remained abundant. Global population has grown by more than half, but the prices of food and most natural resources have dropped significantly.

There is no set point at which "overpopulation" occurs. Middle-range estimates of the planet's carrying capacity run between 7.7 billion and 12 billion, the span we will enter in the next 50 years. But limits depend not only on the number of people but also on how much they consume and produce, and how efficiently. If the entire world consumed resources as profligately as the industrialized world now does—U.S. per capita energy use is 20 times India's—the strain on resources might be overwhelming.

Every year more than 80 million additional people draw on the planet's resources, and we are already pushing against some apparent limits. People use more than half of all accessible renewable fresh water, and that is expected to increase to 70 percent by 2025; nearly a third of all people live in countries where water supplies are stressed. The remarkable gains of the green revolution have tapered off, and most of the best agricultural land is already in production. Furthermore, if global warming disrupts weather patterns, we may face new agricultural and water problems. Then again, a warmer climate might lengthen growing seasons and open more areas to agriculture. We have learned much in the past 30 years, but ultimately we know as little today about what the future holds as we did in 1968. Ideally, we won't discover Earth's limits by crossing them.

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digitaria sanguinalis
(crabgrass)



ambrosia franseria
(ragweed)



taraxacum officinale
(dandelion)



antiquus pila tenisiae
(old tennis ball)

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HONDA
Thinking.

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OCTOBER 1998









2 **POPULATION** *More people means more demands—for space, nourishment, security, opportunity. Can the needs of all be met?*
BY JOEL L. SWERDLOW

■ *Millennium Supplement: Population*

6 **Human Migration** *We are constantly on the move, from countryside to city and nation to nation, driven by ambition, political upheaval, and natural disasters.*
BY MICHAEL PARFIT PHOTOGRAPHS BY KAREN KASMAUSKI

36 **Women and Population** *Birthrates fall and hopes rise as women gain access to education and health care.*
BY ERLA ZWINGLE PHOTOGRAPHS BY KAREN KASMAUSKI

56 **Feeding the Planet** *So far, global food production has kept pace with a burgeoning population. Maintaining that balance and finding ways to share Earth's bounty are critical challenges.*
BY T. R. REID PHOTOGRAPHS BY ROBB KENDRICK

76 **Lewis and Clark** *Enthralled by "Barking Squirils" and unimagined vistas, these naturalist-explorers emerged from the newly acquired Louisiana Purchase in 1806 with a valuable treasure: a detailed account of the land and creatures of the Rockies and beyond.*
BY RON FISHER

94 **Perfume, the Essence of Illusion** *Orchestrating the fragrances of nature—and their chemical counterparts—master perfumers create a commodity no one needs but almost everyone wants. The multibillion-dollar scent industry is smelling like a rose.*
BY CATHY NEWMAN PHOTOGRAPHS BY ROBB KENDRICK

120 **Antarctic Desert** *Scientists studying an ice-free enclave known as the Dry Valleys discover microscopic organisms living inside frozen rocks and minuscule worms that survive freeze-dried for decades.*
BY MICHAEL PARFIT PHOTOGRAPHS BY MARIA STENZEL

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Behind the Scenes
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Geographica
From the Editor

Flashback
On Screen
Earth Almanac
Interactive
On Assignment

The Cover

Glimpsing a brighter future, a girl clings to her pregnant mother, who waits—health card in hand—at a clinic in Bangladesh. Prenatal care has shaved mortality rates for mothers and babies. Photograph by Karen Kasmauski

Cover printed on recycled-content paper.

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NATIONAL GEOGRAPHIC'S

Millennium Moments

Chronicling the Saga of People on the Move

"The citizens of other states come here, not in conquering hosts, but as individuals—to a nation for the most part foreign to the one they left, in customs, in manners, and in government," wrote Z. F. McSweeny, former assistant commissioner of immigration, in the January 1905 GEOGRAPHIC. In those days few public issues were as consequential. A record 1.28 million immigrants poured into the U.S. in 1907, and that May the magazine published nearly two dozen photographs of new arrivals "in their native costume." The cumulative portrait was arresting: Cossacks and Germans, Scots and "Russian Hebrews," "Servian" Gypsies and Arabs, "Hindoos" and "Parsees."

The movement of people—migration—is a basic ingredient of human geography: which people move and why, where they settle and how they adapt, what they eat and what happens when famine strikes, where their trade routes go and what cultural exchange results. Such subjects have engaged this magazine for more than a century. These Millennium Moments are a brief sampling.

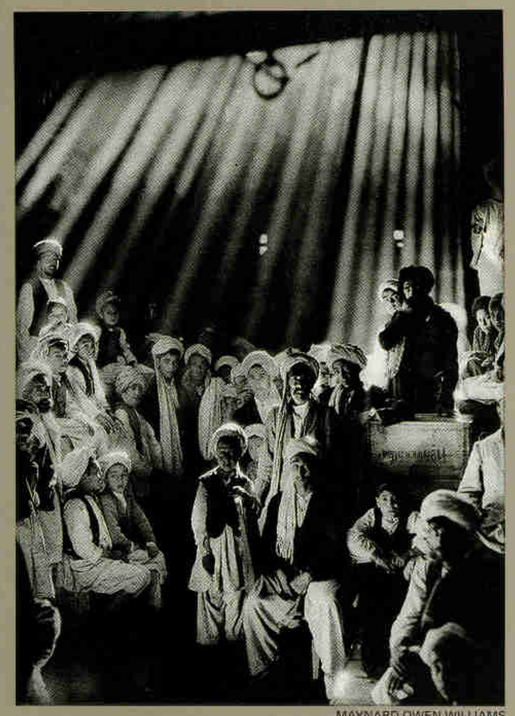


CITY LIGHTS LURE THE MULTITUDES
Electricity made modern cities more livable and encouraged the 20th-century rush from rural areas to urban centers. Facing southeast from 67th Street and Central Park West, photographer Orren R. Louden captured New York City by day and night for the November 1930 issue. Marveled writer Frederick Simpich: "New York! Man's incomparable feat! As incredible, almost, as that ants should have built the Andes!"



ORREN R. LOUDEN (BOTH)

CULTURAL CROSSROADS
"From such a group may have come the Three Wise Men of the East," said the legend for this December 1933 photograph of Afghan men gathered in the gloom of a warehouse in the ancient city of Herat. For almost 2,000 years, beginning about 100 B.C., the people of Herat encountered a variety of cultures as caravans of traders moved east and west along the Silk Road. This crossroads was "a focus of inland learning and trade for centuries," author Maynard Owen Williams noted.



MAYNARD OWEN WILLIAMS

SILENT SENTINELS OF THE DESERT
Mud-brick towers at Shibam rear out of Yemen's desert like ancient skyscrapers. Built centuries ago, the structures testify to the power of the Hadramawt kingdom, which ruled between the first century B.C. and the third century A.D. Shibam's merchants grew wealthy from the frankincense trade that sent the sweet-scented resin to Greece and Rome. Writer and photographer Thomas and Lynn Abercrombie followed the remnants of the Frankincense Trail from southern Oman through Yemen and Saudi Arabia into Petra, in Jordan, for the October 1985 GEOGRAPHIC. The kingdoms of southwestern Arabia created a powerful cartel that controlled the incense trade—"a kind of OPEC of its time," a Yemeni scholar told the Abercrombies.



LYNN ABERCROMBIE

Population Milestones

■ **A.D. 1000-1100**
World population: 300 million. (All global population figures are estimated.)

Arriving in outrigger canoes, Polynesian and Melanesian groups settle New Zealand.

■ **1100-1200**
World population: 330 million.

Mongols of Central Asia invade Iran, Iraq, central Russia, parts of China and India.

Fall of Fatimid dynasty in Egypt in 1171 leads Shiite Muslims to seek sanctuary in Persia.

■ **1200-1300**
World population: 380 million.

Muslim expansion into Syria, Iraq, North Africa, and Spain reaches an end.

■ **1300-1400**
World population: 420 million.

Bubonic plague strikes Europe, killing 25 million people, more than a quarter of the population.

Islamized Africans migrate from western Sudan to establish sultanates in central Africa.

■ **1400-1500**
World population: 460 million.



They call it Operation Smile and it sends teams of surgeons and medical supplies across the globe to help children with disfiguring birth defects. Over the last 15 years, they've saved over 40,000 impoverished children from the pain and humiliation of cleft lips, palates and other serious afflictions. But to its founders, Dr. William and Kathy Magee, this program does more than just repair physical scars. It brings hope to the hopeless, and leaves a smile where there once was none.

with one operation.

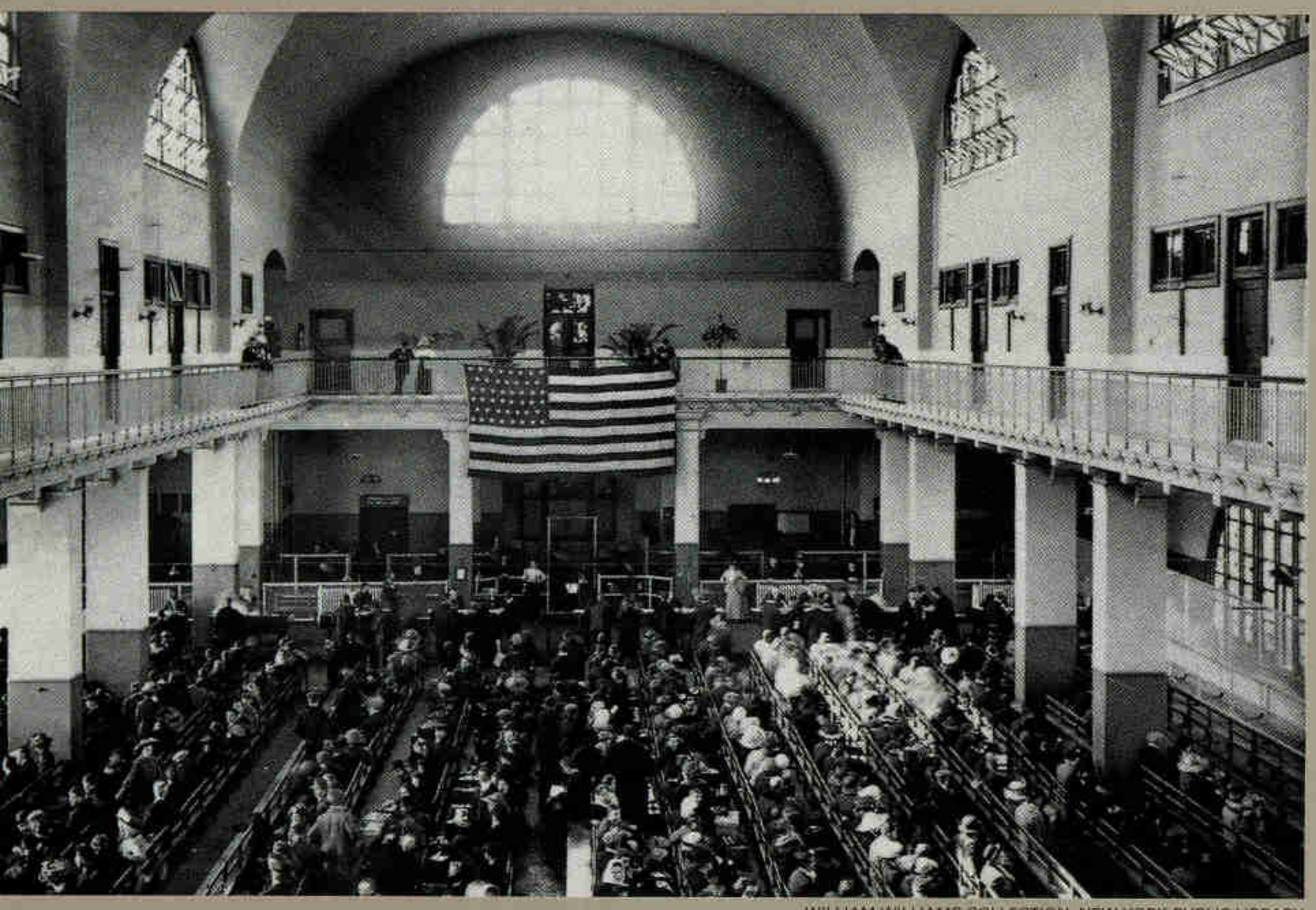
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MILLENNIUM MOMENTS



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THE SPECTACLE OF IMMIGRATION
Huddled together and yearning to breathe free, immigrants to the United States patiently await processing at Ellis Island in 1912. The cavernous Registry Room served as the nation's primary reception depot for millions of newcomers—often 5,000 a day—between 1900 and 1924. Curious citizens frequently came to the room's balcony to view the hordes of arrivals. Ellis Island now is a historic site honoring all immigrants to the United States.

SURVIVORS OF A REFUGEE FLOOD
In a far less orderly scene, a tide of humanity engulfs a warehouse in Hong Kong's Government Dockyard Transit Centre in the late 1970s, when some 300,000 boat people, mostly ethnic Chinese, fled persecution in Vietnam. These refugees, photographed for the November 1979 GEOGRAPHIC, were among the lucky ones; perhaps half of those who crowded on rickety boats or rafts to escape from Vietnam drowned, died of exposure, or perished at the hands of brutal pirates.



WILLIAM ALBERT ALLARD

European discovery of the New World.

Catholic Spain expels 200,000 Jews and Muslims.

Polynesians reach Hawaii.

■ **1500-1600**
World population: 500 million.

African slave trade to the Americas begins.

Spanish explorers and missionaries create colonies in the Americas.

Major European powers—Spain, France, England, and Portugal—establish forts, trading posts, and mineral fields in Africa.

■ **1600-1700**
World population: 600 million.

England and France launch colonies in North America.

■ **1700-1800**
World population: *720 million.*

Medical advances, such as a vaccine for smallpox, lower death rates, leading to a 40 percent increase in population during the 18th century.

■ **1800-1900**
World population: 1 billion.

Millions of Chinese move to other parts of Asia and to the Americas.

Disastrous crop failures in Ireland and elsewhere trigger the largest migration in history as some 17 million Europeans cross the Atlantic to America between 1840 and 1910.

The last of 10 million to 12 million enslaved Africans are forcibly moved to the New World and Europe; another 4.3 million are shipped to the Middle East.

Population increases 70 percent by century's end as development of germ theory and other medical discoveries continue.

■ **1900-2000**
World population: 1.7 billion.

Trans-Siberian Railroad is completed in 1903. During the next ten years five million Russians, mainly peasant farmers, migrate to Siberia.

Immigration to the U.S. from Europe peaks in 1907; by 1910, 14.8 percent of U.S. population is foreign-born.

Turks massacre Armenians in 1915 and 1916; 250,000 Armenians seek refuge in Russia.

Influenza pandemic of 1918 and 1919 kills as many as 40 million people.



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ALABAMA
FEB. 14

I think photographers are part scientists and part artists. The scientist is always asking, "What can I bring forward or push back to get what I want in the shot?" So everything has to do with control and direction and making choices.

But the artist is wondering, "How can I create an emotion?" With the preacher, I wanted to create a story with some emotional appeal. And that's when you make a conscious choice about film. I wanted a film with the color saturated, but I wanted good-looking, natural skin tones too.



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■ **1900-2000 (continued)**
World War I and its aftermath bring political and cultural upheavals; migration drops due to economic stagnation and xenophobia.

Nazi Holocaust kills some six million European Jews in World War II. Many survivors find homes in the U.S. and the newly established state of Israel.

As India gains independence from Britain, ethnic conflict uproots 15 million people. Hindus and Sikhs flee what will be Pakistan and Muslims from India move in.

Between 1955 and 1985 world grain production doubles as a result of the green revolution. But periodic famines still plague peoples of the developing world.

Revolutions in Africa and Cuba, wars in Southeast Asia, and a fractured Yugoslavia cause new migrations. United Nations refugee programs serve as many as 27 million a year.

Immigration to the U.S. rises to more than 800,000 people a year in the mid-1990s, with the largest influx from Mexico, Central America, and Asia.

African urban centers surge as millions migrate from outlying areas to burgeoning cities.

Worldwide population rises by more than 80 million a year in the late 1990s.

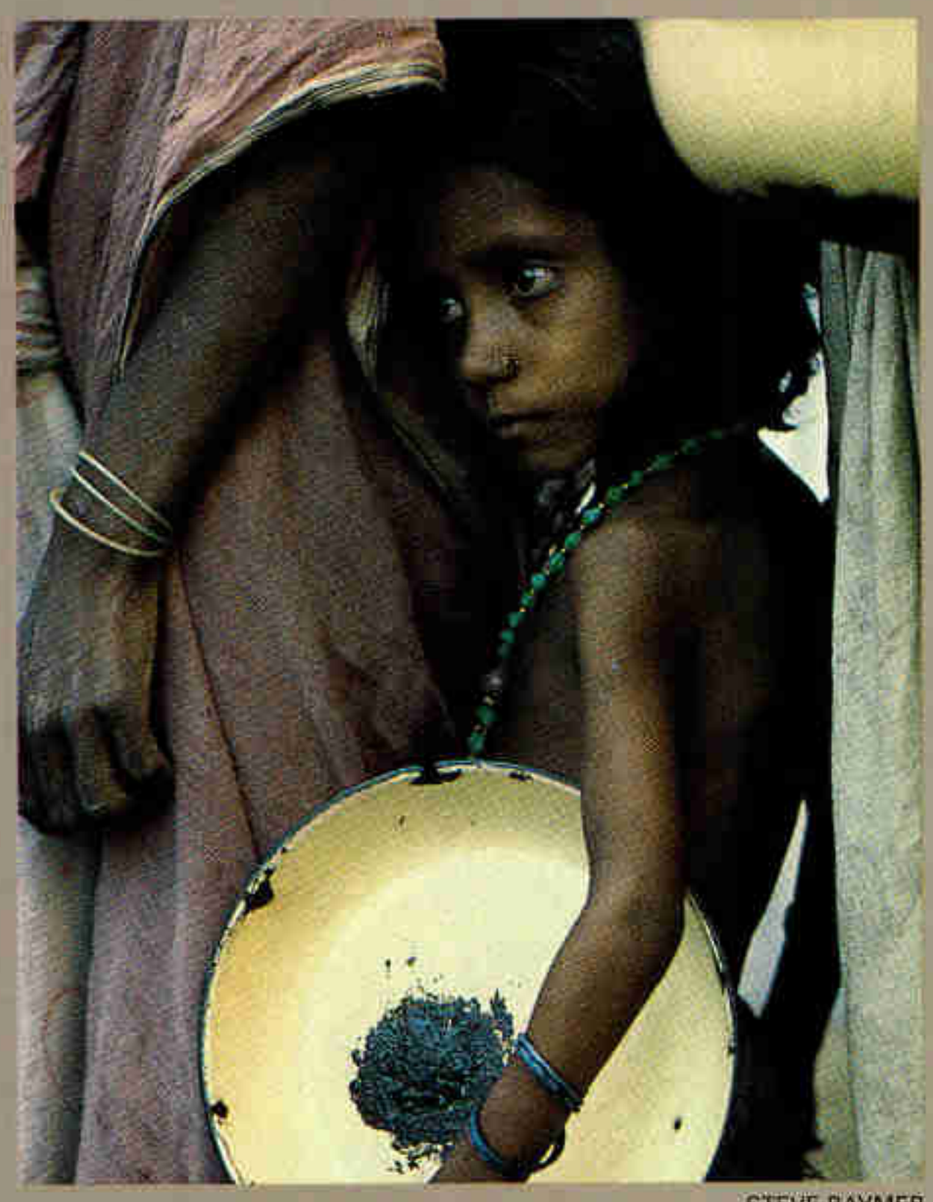
■ **2000**
Projected world population: 6.1 billion.



J. BAYLOR ROBERTS

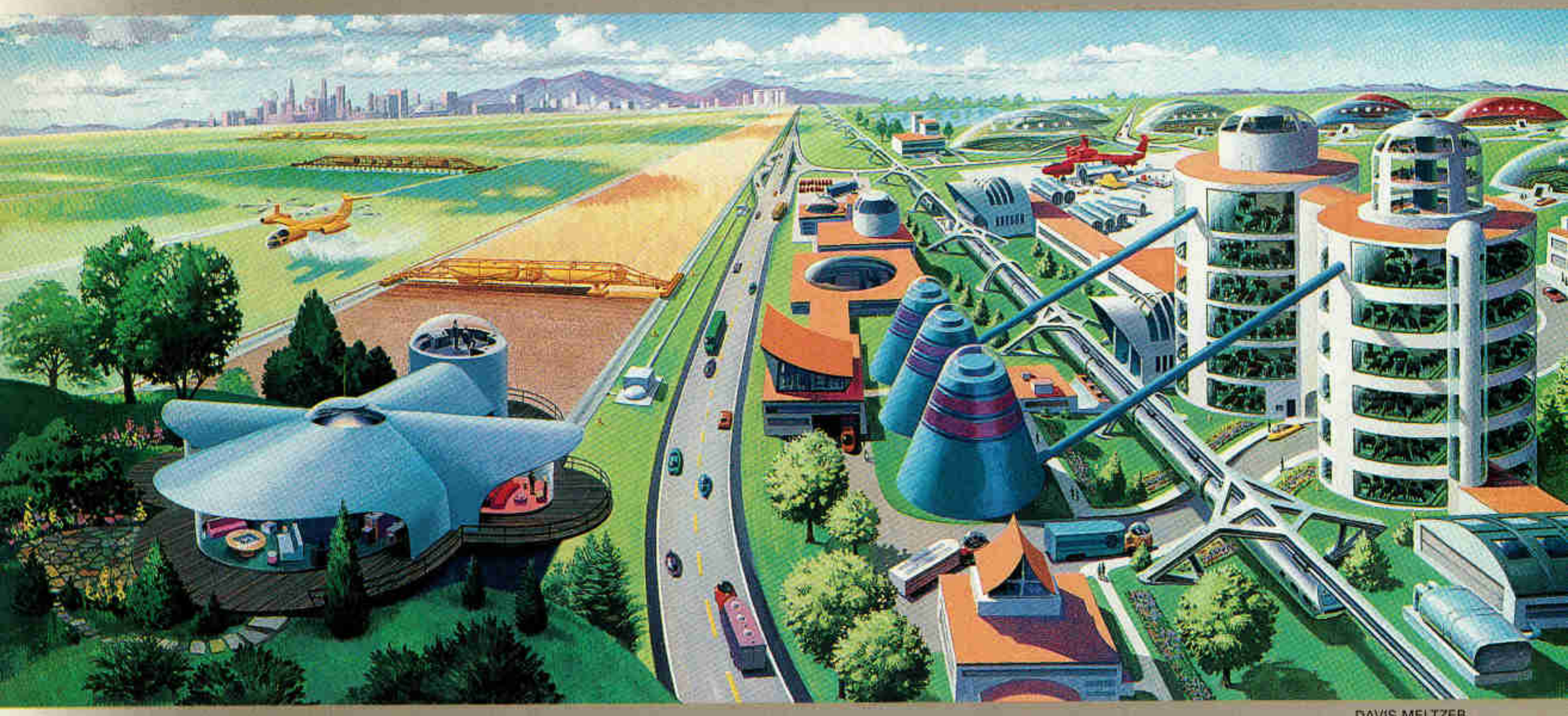
FOOD FOR THE MASSES
Sides of beef get the stamp of approval in a Swift Premium chill room in Chicago. The magazine's March 1942 article "Revolution in Eating" heralded the arrival of the machine food age, in which transportation, processing, refrigeration, metal cans, and pasteurization all helped bring food from afar to ever growing numbers of city dwellers. "Read any month's itemized grocery bill for a thrilling chapter of applied geography," advised author J. R. Hildebrand.

CHILD OF CATASTROPHE
The despair of this girl waiting for relief rations during a famine that wracked Bangladesh in 1974 puts a human face on a disaster of such magnitude that it often seemed impersonal. Droughts and floods, a shortage of farmland, scarce fertilizers, dependence on imported energy, a threatened ecosystem: All contributed to the Bangladesh famine. It was just one battle in "the ceaseless war against hunger, as old as man himself," Thomas Y. Canby wrote in the July 1975 issue.



STEVE RAYMER

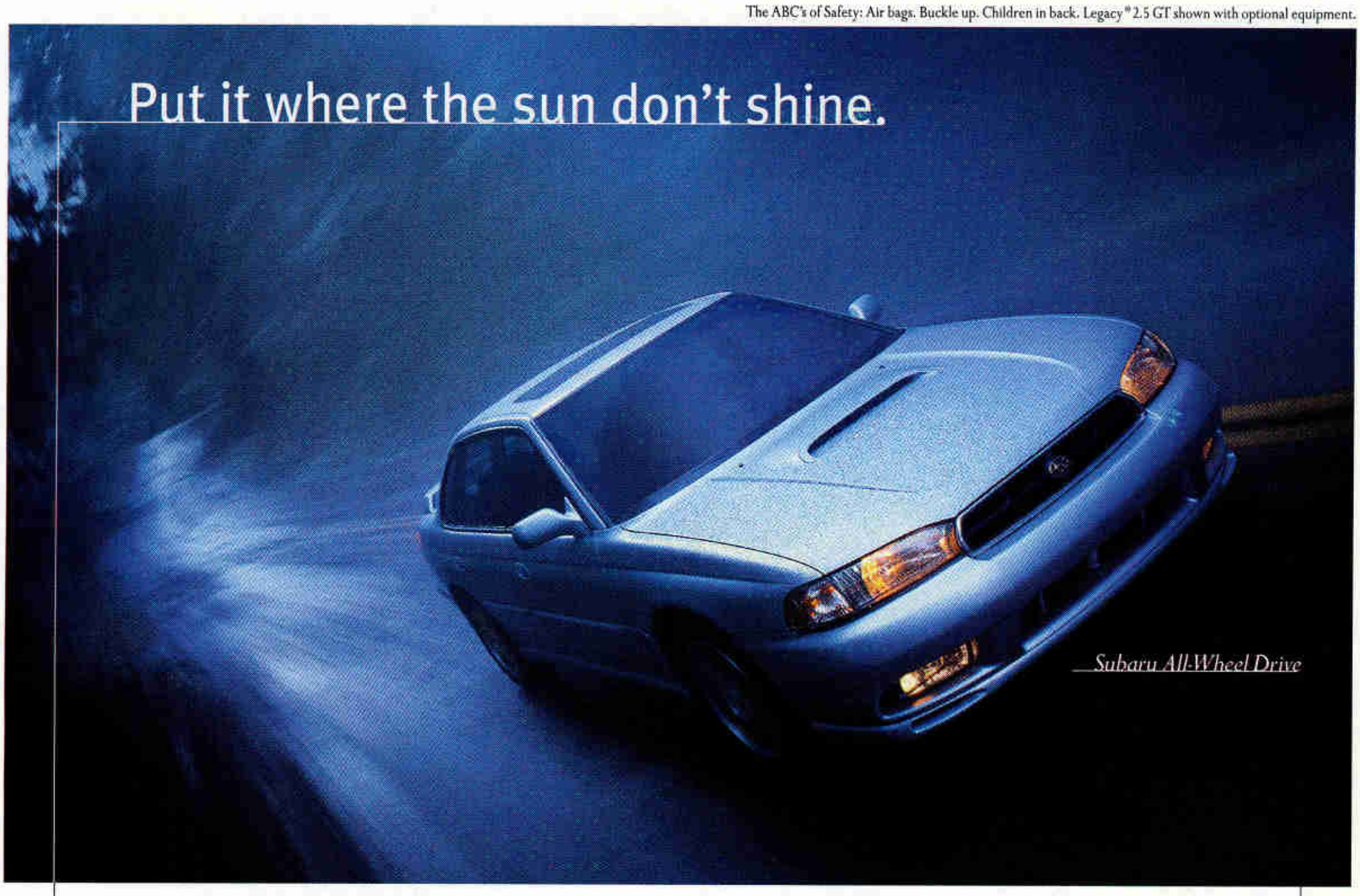
A FARM YET TO COME
Peering through a faulty lens into the future, an artist envisioned a 21st-century farm for the February 1970 issue. Fields stretch like fairways, cattle fatten in high-rise pens, threshed grain flows through pneumatic tubes into storage elevators, and a control tower oversees all. History fed optimism: "In a single lifetime, U.S. agriculture has advanced more than in all the preceding millenniums of man's labor on the land," wrote author Jules B. Billard.



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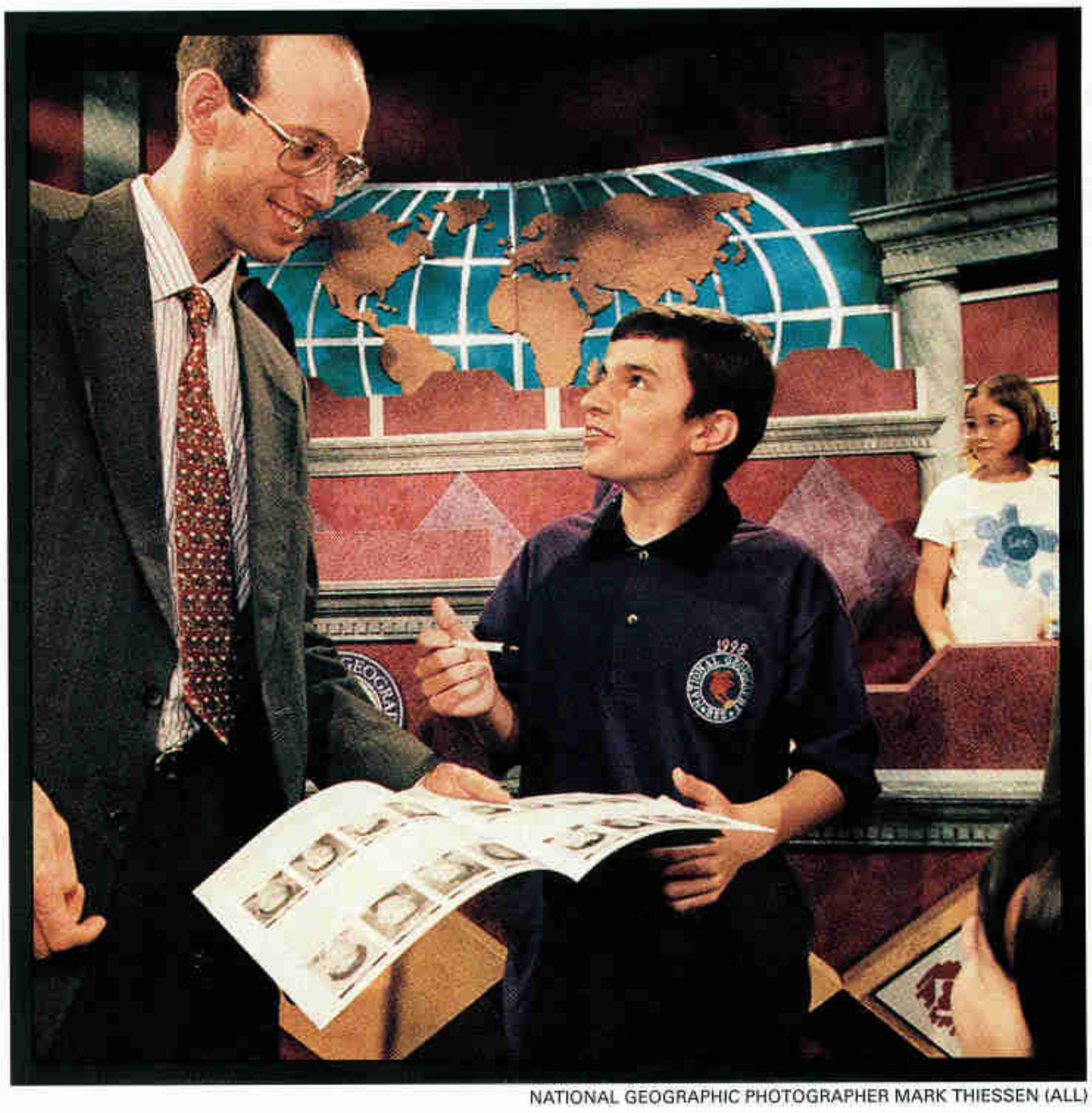
Behind the Scenes

On Top of the World

His third trip to the National Geography Bee finally paid off for Petko Peev this year. The Grand Rapids, Michigan, 13-year-old (right)—congratulated by 1989 winner Jack Staddon, our first ever Bee champ—went home with a $25,000 scholarship, a trip to Hong Kong, and a lifetime membership to NATIONAL GEOGRAPHIC. What did it take to win? "Persistence," says Petko.

Two days of competition in Washington, D.C., last May meant plenty to ponder for all 57 contestants, including (from left) Missouri's Eapen Thampy, Nevada's Peter Guekguezian, Arkansas's Benji Hardy, and Kevin Samuels of Oregon.

Some five million other students nationwide competed in the Bee's preliminary rounds this year. The Bee was co-sponsored by the Society and Sylvan Learning Centers.



NATIONAL GEOGRAPHIC PHOTOGRAPHER MARK THIESSEN (ALL)









Ben Returns—One Last Time

"I'm retired now," sighed 14-year-old Ben Graber as he watched the finals of the 1998 National Geography Bee. Though knocked out in the first-day semifinals this year, Ben still achieved something no other student has in a decade of the competition: winning as a state champion four years in a row. For three years he was the Georgia winner, and when his family moved to West Virginia last summer, he aced that state's Bee championship too. Ben, at left, enjoys spending time with friends during his "retirement." He also has his eye on a goal that could put all that Bee knowledge to use. "I might want to be a writer for NATIONAL GEOGRAPHIC."



TOM COGILL

The true measure of success in life isn't money, fame or power. It's laugh lines.

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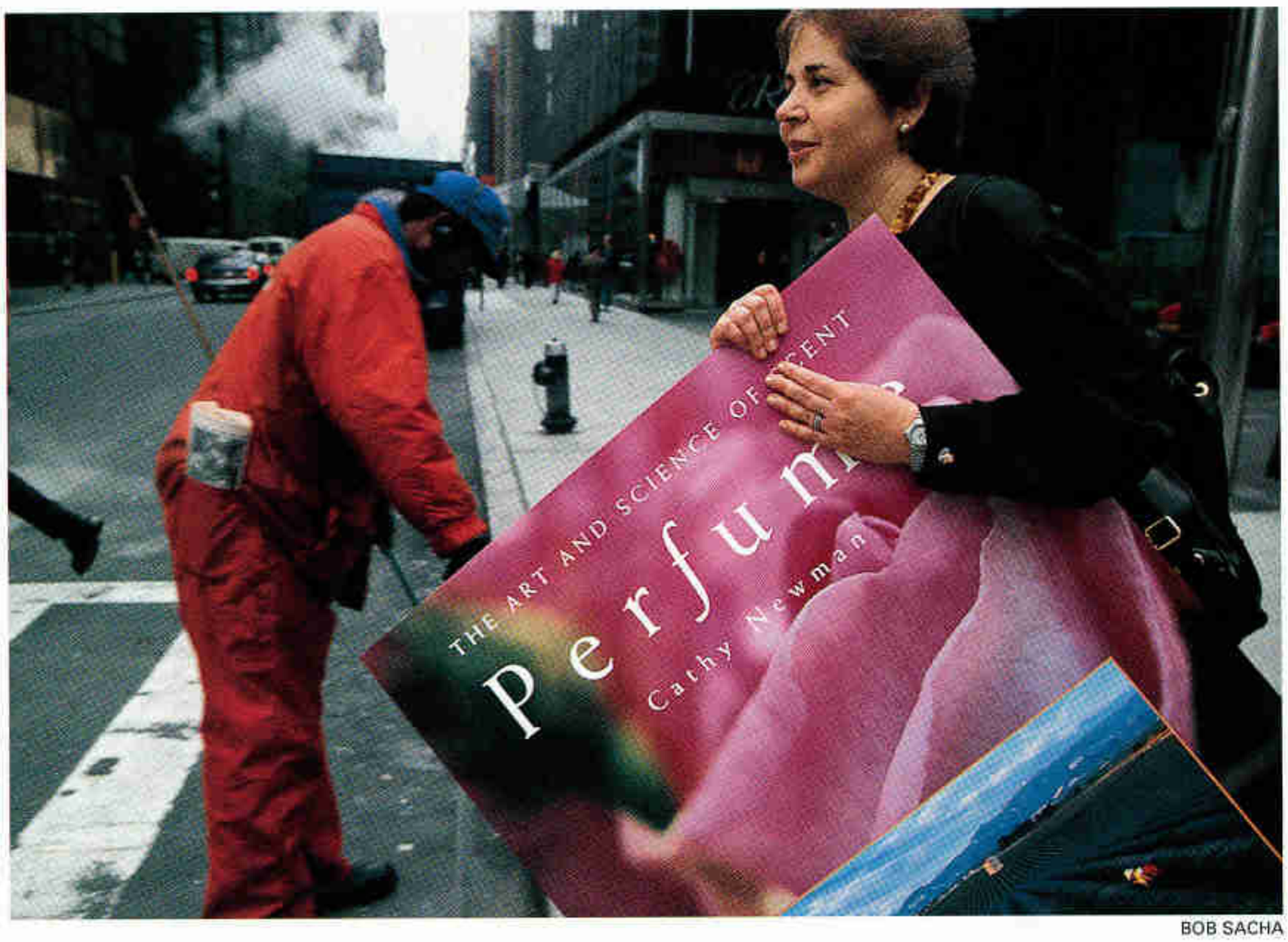


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BOB SACHA

Promoting her first book, *Perfume: The Art and Science of Scent,* in New York City, author Cathy Newman (right) had a revelation. Meeting with stylish fashion magazine editors, she realized "they are just like any exotic tribe anywhere. They have their own language, special eating rituals, and costume—basic black." Suddenly Cathy, who has written for the GEOGRAPHIC for 20 years, felt right at home.

Researching the book was a world of adventure: She sank into rose petals in Morocco, attended a school for perfumers in France, and learned to distinguish among jasmine oils from France, India, and Egypt. You can find *Perfume* in bookstores this month.

Giant Penguins Invade Tokyo

Seven-foot-high emperor penguins turned heads at a busy Tokyo intersection last spring—all part of the celebration marking the third anniversary of NATIONAL GEOGRAPHIC's Japanese edition. An outdoor display at the Ginza Sony Building featured a re-creation of photographer Frans Lanting's 1996 cover. Inside, copies of the Japanese GEOGRAPHIC were exhibited, while NG Television films previewed at a free theater and NG Interactive CD-ROMs were loaded onto computers, ready for play.

Our International Editions staff now has something new to celebrate: A Greek-language GEOGRAPHIC debuts this month.



TORIN BOYD

Placeholder in History

In February 1936 the GEOGRAPHIC offered free bookmarks cut from the skin of the *Explorer II* stratospheric balloon; Donald Jacobs of Victoria, British Columbia, sent for one. Over the years, says the avid reader, now 92, "I was always losing it in my books." He's since solved the problem. "I just keep it on my TV."

TEXT BY MAGGIE ZACKOWITZ



PHIL SCHOFIELD

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SEXUAL HEALTH

Most men will have an isolated erection problem at some time in their lives, but for others it happens more frequently. If the inability to respond naturally to your partner has become a recurring problem, you may be suffering from a treatable medical condition called erectile dysfunction (E.D.), also known as impotence. The following questions and answers are designed to give you a brief introduction to the causes of E.D. and the various treatment options available. If you believe you are suffering from E.D., or want to know more about the condition, talk to your doctor or other healthcare professional.

ERECTION PROBLEMS: WHAT EVERY MAN SHOULD KNOW

WHAT IS E.D.?

Erectile dysfunction is the consistent inability to achieve and/or maintain an erection sufficient for satisfactory sexual activity. That means not just an occasional problem, but one that has been occurring repeatedly for a period of time. It's a widespread condition, shared by approximately 30 million men in the United States.

WHAT CAUSES E.D.?

It was once believed that E.D. is all in your head, or just an inevitable result of getting older. Actually, the majority of E.D. cases are associated with physical conditions or events, including some that are age-related.

The most common risk factors for E.D. include:

- *Diabetes, high blood pressure, hardening of the arteries, or high cholesterol*
- *Injury or illness, such as spinal cord injury, multiple sclerosis, depression, stroke, or surgery for the prostate or colon*
- *Medications that may bring about E.D. as an unwanted side effect*
- *Cigarette smoking or alcohol/drug abuse*
- *Psychological conditions, such as anxiety and stress*

If you want to know more about E.D., talk to your doctor.

CAN ERECTILE DYSFUNCTION BE TREATED?

Yes. The good news is that, regardless of the cause, the vast majority of E.D. cases are treatable. Patients have a variety of treatment options from which to choose, including oral medication, hand-held vacuum pumps, self-administered injections, pellet suppositories, and surgical implants.

CAN ANYONE USE THESE TREATMENTS?

It's important to remember that these treatments are not for everyone, but only for men diagnosed with E.D. You and your doctor can determine the appropriate treatment for you.

HOW DO I KNOW IF I HAVE E.D.?

If you have erection problems, you probably already know it. But before your condition can be treated, you need to get a diagnosis from your doctor. There is no need to be embarrassed or ashamed when discussing E.D. with your doctor. He or she has probably diagnosed and treated E.D. many times but may not have discussed it with you out of respect for your privacy. Your doctor can provide you with understanding, support, and best of all, information.

To diagnose E.D., doctors typically ask a few specific questions and give a routine physical exam. This should help your doctor arrive at a diagnosis.

Based on this information, you and your doctor will decide on the treatment that is best for you.

REMEMBER:

E.D. is a common medical condition.

It's not an inevitable result of growing older.

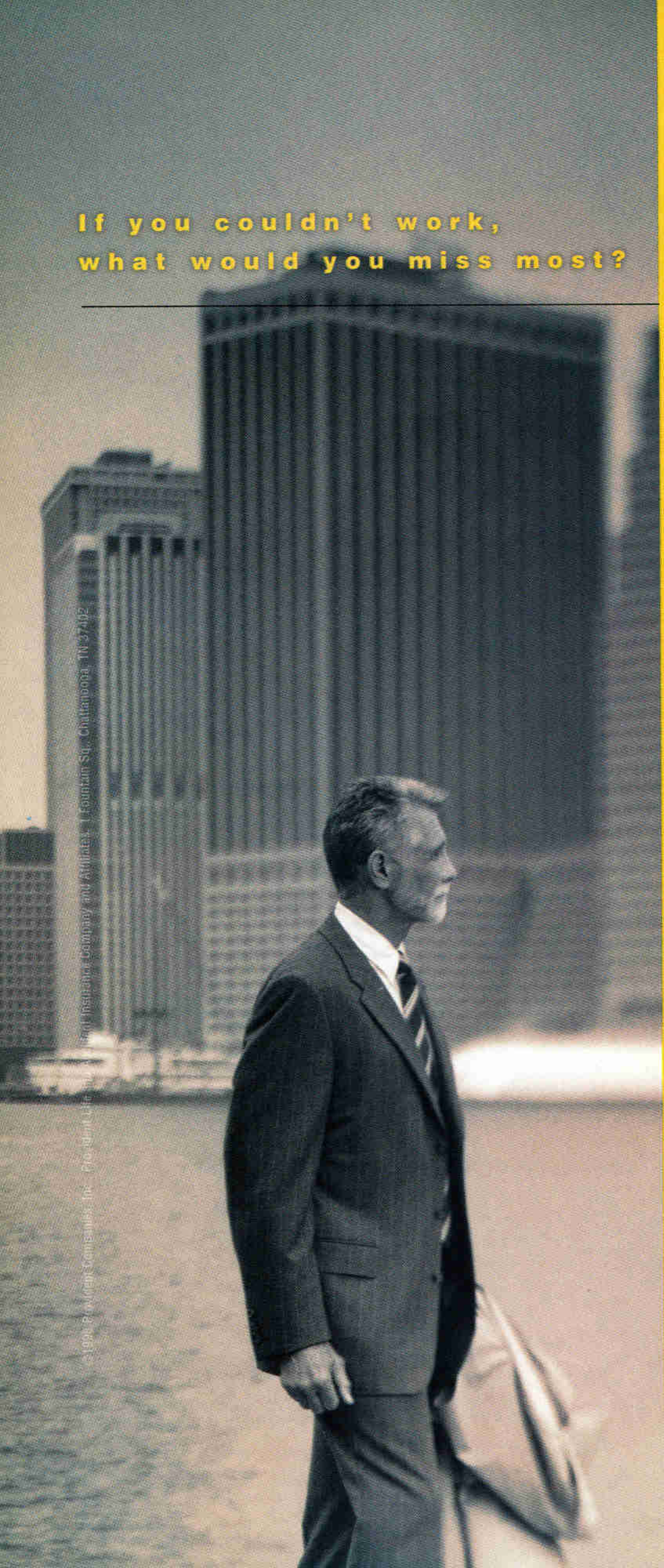
E.D. is treatable with a variety of methods.

Only your doctor can prescribe the appropriate treatment.

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The challenge?

The adrenaline?

The paycheck?

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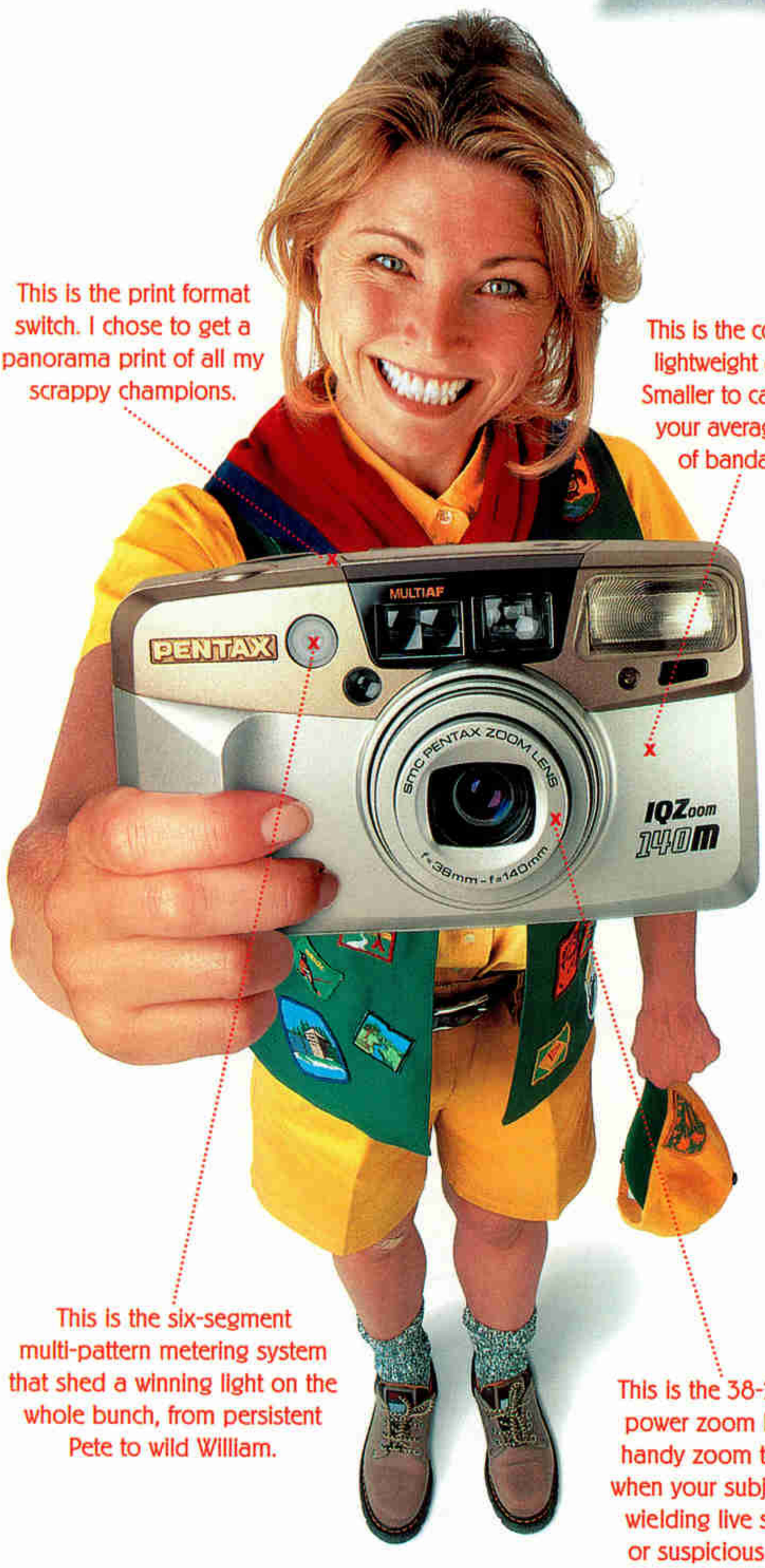


My Photo

How I captured my little Badgers, after they emerged victorious from "Capture the Flag."

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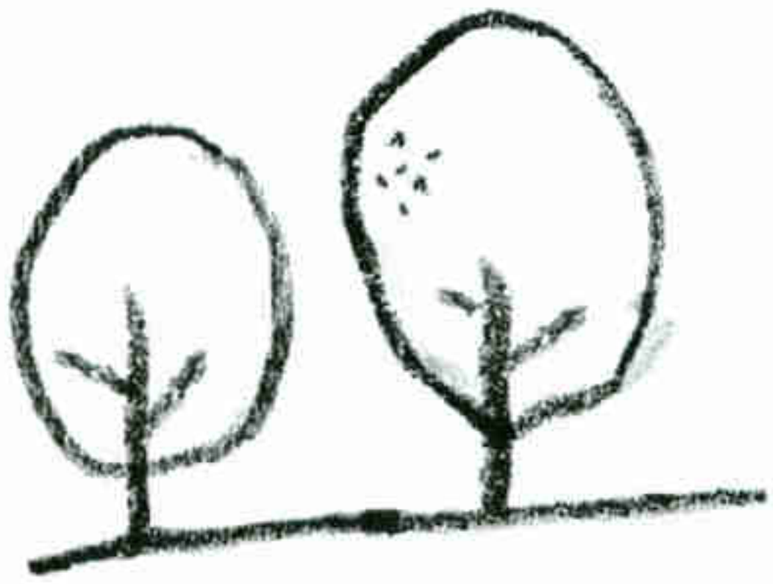
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Forum

Larry Gniewek from Halfmoon, New York, summed up the June issue's offerings: "Where else can you see transportation in such contrast? One country struggles to keep itself tied together with iron rails while another views modes of transportation in recreational terms. I am a defense-plant worker who may soon be unemployed. My only consolation is that I can drive up to the Adirondacks and contemplate all of this in solitude."

Trans-Siberian Railroad

As a Russian-language teacher who takes high school students to Russia on an annual exchange program, I have traveled on the Trans-Sib countless times. There are two windows on the train: the physical ones, which look out onto the birch forests and summer cottages, and the emotional ones, which look into the souls of perhaps the most interesting and hospitable people in the world.

JIM SWEIGERT
Cedar Falls, Iowa

My late husband lived a few steps from the railroad in Khabarovsk. When U.S. soldiers arrived in 1918, he left his family at age seven to live with troops encamped along the railroad. Posing as an orphan, he stayed in the camp of G Company, 27th Infantry, Siberian Expeditionary Force, in the village of Sviagino and later sailed as a stowaway to the Philippines with the company in 1920. I have been living vicariously with the Trans-Sib for over 60 years.

CONSTANCE LANGTRY
Wilmington, North Carolina

According to writer Fen Montaigne, today it takes about six days to travel from Moscow to Vladivostok. In 1946, after I was taken as a prisoner from Hungary by the Soviets, I was shipped on the Trans-Siberian Railroad almost without food or water in locked-up railroad cars. The trip took one month in the winter, and I almost lost my life.

This railroad was built partly by hundreds of thousands of political prisoners, and millions of innocent people were transported on it to their death in the Siberian labor camps, the gulags.

GEORGE Z. BIEN
Fairfax, Virginia

America had a part in the Trans-Siberian Railroad. Russia said that it would use the Westinghouse air brake on trains if the air brake was built on Russian soil. My father-in-law, Frederic Huntington Parke, general engineer for Westinghouse Air Brake and perfecter of its product, went to Russia in 1895 to build the air-brake factory. He and his wife had a most interesting life in St. Petersburg during the time of Nicholas and Alexandra.

CATHERINE PARKE NICHOLSON
Greenwood, South Carolina

In 1988 I traveled on the Trans-Siberian Railroad with 13 classmates to study Russian language and culture. Once I saw a woman selling milk and tried to buy some for the little girls in the next compartment. I used my best Russian to ask what kind of milk she had. Was it goat or cow? She didn't answer, but when I turned away, she said, "Moo!"

LOUISE M. HARRISON
Detroit, Michigan

The Elusive Quetzal

I was much intrigued by the excellent image on page 43 of a quetzal family at feeding time. How did Steve Winter make the photograph without setting the birds in panic?

GONÇALO VELEZ
Lisbon, Portugal

A hole that could be covered was cut in the tree at night, and a blind that admitted no light was erected around it. A few days later, after the adults had become accustomed to the blind, Steve Winter climbed into it. When he heard the whistled signal from his assistant below that an adult was approaching, he raised his camera to the hole. Giving the quetzal a few seconds to start the feeding, he took the photograph using a miniature flash, which did not seem to bother the birds. This nest was chosen because the chicks were on the verge of fledging.

Orkney Islands

Numerous Orkney Islanders immigrated to Canada in the 18th and 19th centuries. At first the Hudson's Bay Company sent Englishmen to run their trading posts—mostly in the Hudson Bay area—but living conditions were so harsh and lonely that they could not keep their employees. The company discovered that Orcadians, used to even worse conditions at home, were willing to settle and stay in Canada.

Judging from the number of requests for genealogical information on various Internet forums, quite a few North Americans are tracing their ancestry back to those hardy Orcadians.

J. M. FORTIER
Verdun, Quebec

Scapa Flow in the Orkney Islands played an important role in British naval history. It was the base of the British Home Fleet in both the First and Second World Wars. The defenses were neglected between the wars, and on October 14, 1939, a German submarine managed to sneak through Kirk Sound and torpedoed the battleship *Royal Oak,* which sank with a loss of 833 officers and men.

ARNO SCHMIDT
Jackson Heights, New York



ISIS cellular phone

I was really bummed I couldn't
Especially when they sent

Myna musical pager







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* April, 1998 Test by CNET: The Computer Network **with the optional high-capacity battery. Talk and standby times are network dependent and differences between networks may exist. © 1998 Philips Electronics North America Corp.

PHILIPS

Let's make things better.

Two of my grandparents were Orcadians, and I still have relatives on the islands. I can testify to the tremendous strength of the winds. During World War II, while serving in the Royal Air Force, I learned of an occasion when an exceptionally high wind blew the wooden RAF station church over the cliffs into the sea. This was reported, rather laconically, as "Station church airborne 0705 hours."

ROBERT B. KENNEDY
Spring Valley, California

Stock Car Racing

The NASCAR phenomenon is not just a Southern happening; it is an American obsession. Thank you for an enlightening look at ourselves through our vehicles.

GREG BEACHEY
Cassopolis, Michigan

An entire article about polluting machines circling a track is a waste of effort and an insult to those of us who know that articles on biodiversity, indigenous cultures, and other intelligent topics are what the magazine is supposed to be about.

LYNN AND PETE WILSON
Chico, California

No disclaimers or apologies are warranted for your article on stock car racing. All-volunteer teams sacrificing and working together toward a common goal on shoestring budgets only for the right to claim that on that night, for that race, they were the best. This is racing and this is the American spirit.

CARL L. MARBURGER
Fremont, California

Raji Honey Hunters

As a resident of the Sierra Nevada foothills I have more than experienced the power of nature, thus giving me great respect for those who go to the forest for strength and life. As I look around my society today and see many who live a life fully serviced by the cushions of TV and microwaves, I wish that more could feel the exhilaration of working in rhythm with nature as the Raji do.

SHANNON CRAM
Nevada City, California

Mysteries of Kaikoura Canyon

I noticed something on the painting on page 115 that your editors didn't catch. The squid getting eaten by the whale has only eight arms, but all squid have ten arms.

NATHAN D. KLUG
Kalispell, Montana

You're right. The squid should have eight short arms and two longer tentacles.

Adirondack High

Thank you for stirring up happy memories of childhood summers in the Adirondacks. I have been trying to explain for 20-plus years to my friends in the Rockies how truly wild the Adirondacks were and are. Your article may remove the looks of skepticism from their faces when I explain that the wildest part of the lower 48 is in upstate New York.

BARBARA SAWYER
Denver, Colorado

I had to smile at author John G. Mitchell's defensiveness about the diminutive size of the Adirondack Mountains. It is true that "the truest ascent, as distinct from elevation, is where you and the mountain start from." I would invite him to come to Salt Lake City and take a day hike to the top of one of several modest 11,000-foot peaks in the Wasatch Range. However, there is more to a mountain than just the difference in the elevation at the base and summit, and the Adirondacks have a personality all their own. I do not begrudge them the title "mountain."

CARL R. BROWN
Sandy, Utah

I've been in most of the national parks in the States, and each has its own spectacular beauty. I've lived in Alaska over 51 years, and without question it is number one with me. But the Adirondacks take second to none in the fall. Westerners may call them hiccups; however, I imagine if the Rockies were as old as the Adirondacks, they too would be worn down somewhat.

STAN WILK
Anchorage, Alaska

The title of true defender of the forever wild Adirondacks in today's world goes to the pesky blackfly. Without this annoyance no legislation could possibly stand in the way of paradise being sold and developed, fueled by human greed.

MITCH DEHOND
Essex Junction, Vermont

Geographica

I just about fainted when I read your feature on Point Conception. You see, I lived on the site. I remember lighting the lamps at the lighthouse with my father, who was in the Coast Guard. My family and three others lived there in 1964-65. I was one of nine children who attended one of the last one-room schoolhouses in the area.

NAOMI PHILLIPS
Oakley, California

Letters for Forum should be sent to National Geographic Magazine, Box 98198, Washington, D.C. 20090-8198, or by fax to 202-828-5460, or via the Internet to ngsforum@nationalgeographic.com. Include name, address, and daytime telephone. Letters may be edited for clarity and space.

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Richie Hiatt Led Over 200 People In The Fight Against Cancer

That's Why He's a Prudential Spirit of Community Award Honoree

"If you really believe in yourself and your cause, others will too."

Richie Hiatt
1998 Prudential Spirit of Community Award Honoree

Richie Hiatt, 14, of Los Alamitos, California, knew he could make a difference when he began his charge to raise money for kids with cancer. He just didn't realize how big a difference. Exceeding his goal of $1,000—and raising more than $15,000—has earned him a place among the 1998 Prudential Spirit of Community Award honorees.

The search for 1999 candidates is now under way. Prudential created the Spirit of Community Awards in partnership with the National Association of Secondary School Principals to honor young people like Richie for outstanding community service. We're looking for young people in grades 5–12 who have taken it upon themselves to help their communities.

Local, state and national awards. Applications will be available in September through middle schools, high schools, Girl Scout Councils and county 4-H organizations. Local honorees are selected in November and become candidates for statewide honors, a $1,000 prize and a trip to Washington, D.C. In the capital, ten national honorees will each receive a $5,000 award, a gold medallion and a crystal trophy.

Get involved today! If you know any volunteer-minded students, encourage them to apply. The application deadline is October 30, 1998. For more information, call the NASSP at **1-800-253-7746 ext. 324.**

nassp
National Association of Secondary School Principals

Prudential

This program is supported by the American Association of School Administrators, the Council of the Great City Schools, the National Middle School Association, the National School Boards Association, the National School Public Relations Association, Girl Scouts of the U.S.A. and the National 4-H Council. The Prudential Insurance Company of America, 751 Broad Street, Newark, NJ 07102-3777.



Siberian Tiger *(Panthera tigris altaica)* **Size:** Head and body length, 140-280 cm; tail, 60-95 cm **Weight:** Up to 320 kg **Habitat:** Deciduous and evergreen forests in the Russian Far East **Surviving number:** Estimated at fewer than 500 in the wild

Photographed by Maurice Hornocker

WILDLIFE AS CANON SEES IT

A wild Siberian tiger stares intently across a clearing before disappearing back into the forest. Also called the Amur or Manchurian tiger, this is the world's largest cat and the only tiger that lives in a cold climate. Their large and heavily furred feet ease travel in the snow. Shy and solitary animals, Siberian tigers silently roam remote boreal forests in search of elk and wild boar. Reduced to just a few hundred, these magnificent cats were saved from imminent extinction through concerted efforts to learn more about their behavior in the wild, and to preserve remaining habitat and halt poaching. As a global corporation committed to social and environmental concerns, we join in worldwide efforts to promote greater awareness of endangered species for the benefit of future generations.

Digital Camera
Compact and lightweight, the palm-size PowerShot A5 digital camera packs the latest technology in its all-metal body, holding up to 236 images with a standard 8MB CompactFlash memory card.



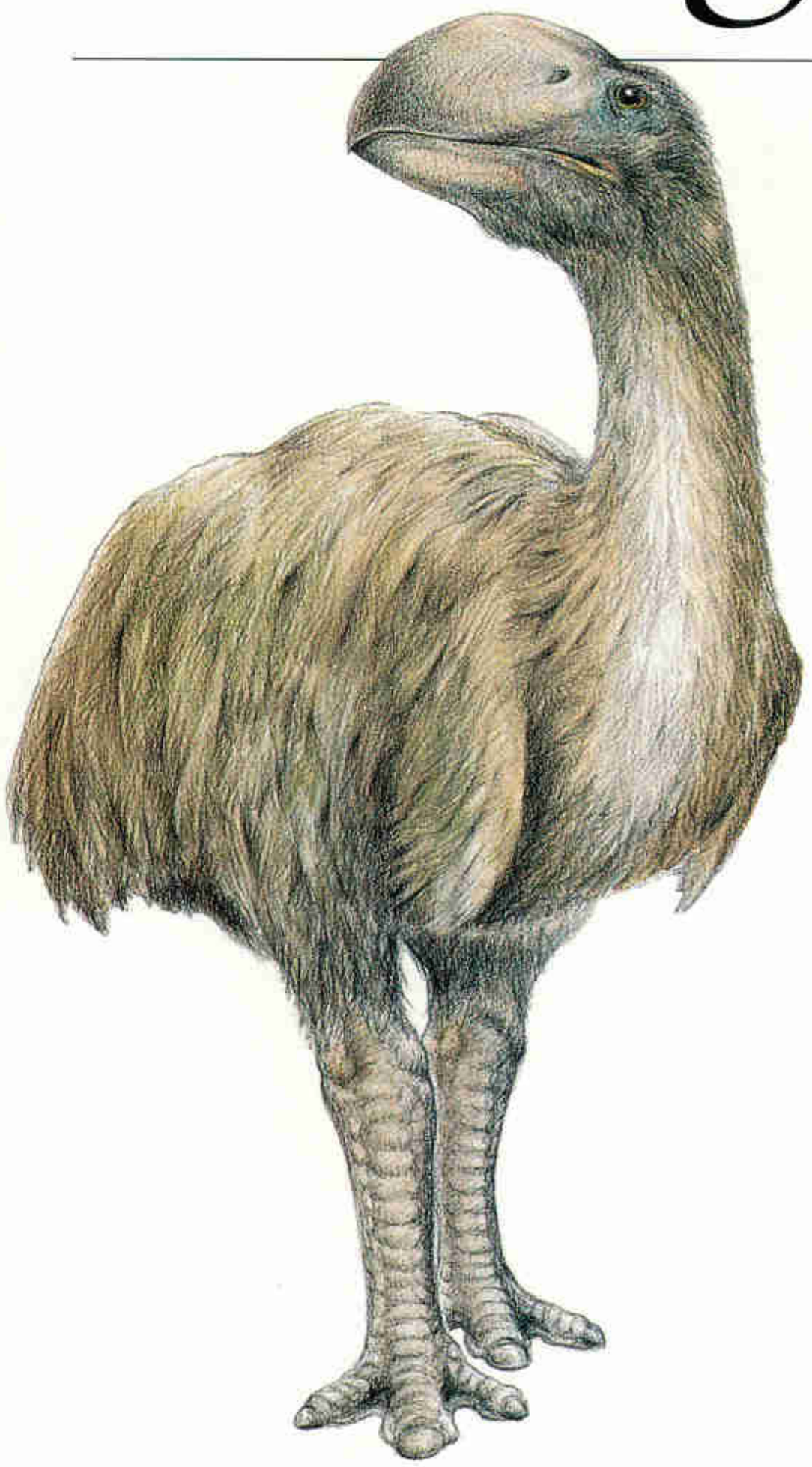
NATURE

Watch "NATURE" on PBS. This program is funded, in part, by Canon U.S.A., Inc.

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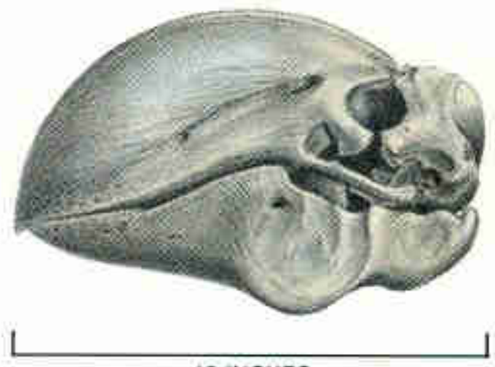


ART BY PETER F. MURRAY

Big Bird Too Large for Sesame Street

If it walks like a duck and quacks like a duck, the saying goes, then it's a duck. A ten-foot-tall, 1,500-pound bird that hung around a water hole in the outback of Australia eight million years ago didn't quack, but paleontologist Peter F. Murray says it was a gigantic duck—or maybe a goose.

It is the biggest bird yet known, slightly larger than the previous titleholder, Madagascar's elephant bird, which became extinct about 500 years ago.



18 INCHES

Murray has excavated remains of *Dromornis stirtoni* at Alcoota, 100 miles northeast of Alice Springs. At Camfield Station, 250 miles north of Alice, the Northern Territory Museum scientist also uncovered several skulls of a slightly smaller but related bird, *Bullockornis planei* (left and above), which was four million years older.

The two had been known only from fragmentary remains, which made it difficult for experts to place them in the avian scheme of things. But Murray's finds have enabled him to make a detailed examination of the birds' characteristics. He concludes that their closest relatives are geese and ducks, not ratites like the kiwi or the emu, as had previously been thought.

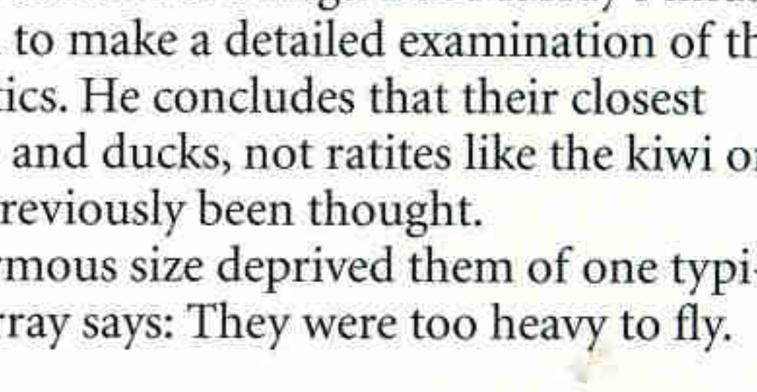
The birds' enormous size deprived them of one typical bird trait, Murray says: They were too heavy to fly.

Costa Rican Gold Returns Home

After U.S. customs agents seized pre-Columbian artifacts from two Costa Rican men smuggling them into the U.S. at Niagara Falls in 1994, art historian Cynthia A. Conides of Buffalo State College pronounced the 69 gold and jade pieces "of museum quality." Now the collection, including this gold frog pendant more than 500 years old, has been placed in the National Museum of Costa Rica.

Conides identified the artifacts, probably destined for the thriving illegal art market, as made between A.D. 1 and 1500 using a gold casting technique that originated in South America. The "beautifully crafted" objects came from the tombs of chieftains buried with personal adornments indicating their high rank, she said.

U.S. Customs Service officials presented the priceless treasures to delighted museum officials last January.



CYNTHIA A. CONIDES

A KNIGHT IN SHINING DOUBLE-SIDED GALVANIZED STEEL.

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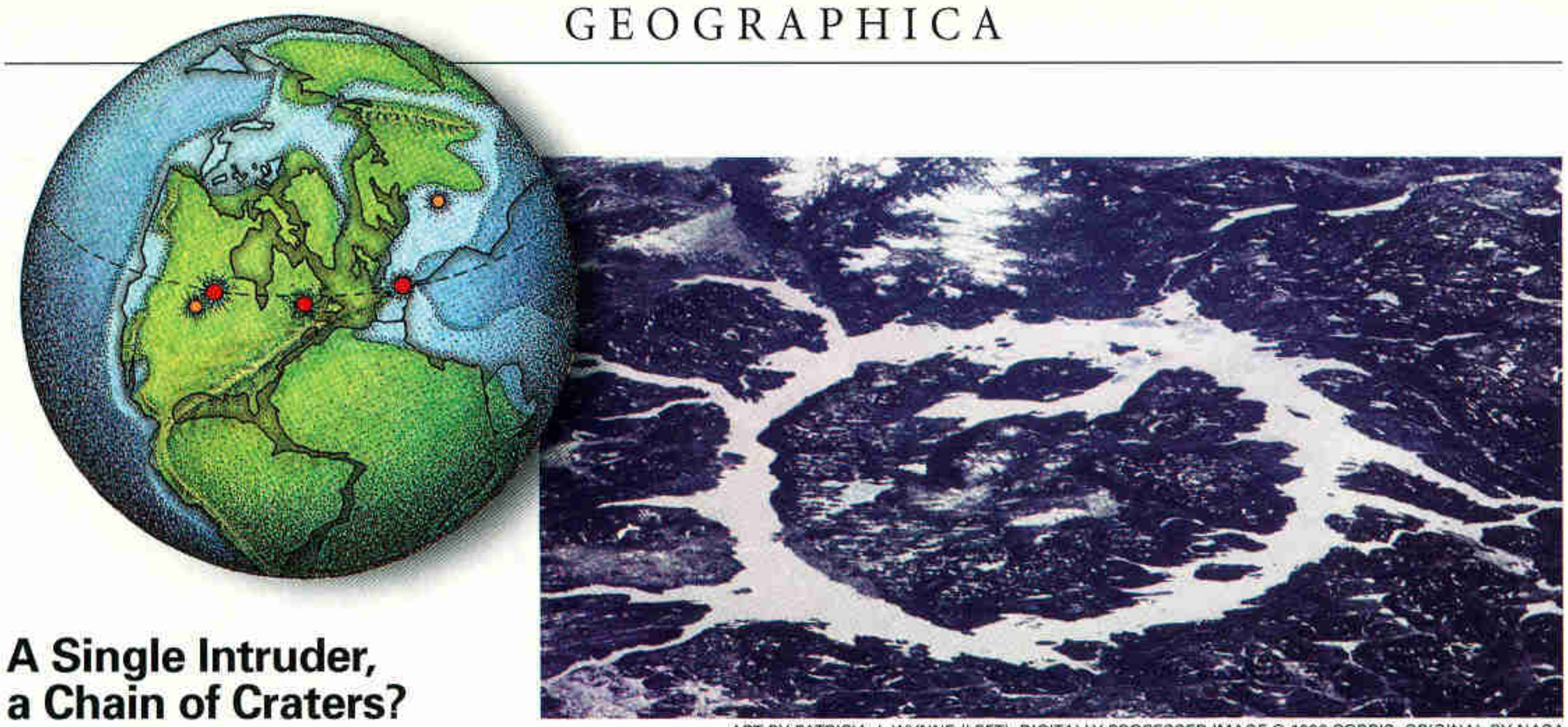
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ART BY PATRICIA J. WYNNE (LEFT); DIGITALLY PROCESSED IMAGE © 1996 CORBIS, ORIGINAL BY NASA

A Single Intruder, a Chain of Craters?

It's a common science fiction plot: A comet or an asteroid strikes Earth, causing vast harm. It does happen. Impact by extraterrestrial bodies has created more than 150 known terrain features. Now scientists report that three—and possibly more—such formations were caused by chunks of a single asteroid or comet as it sped around the planet.

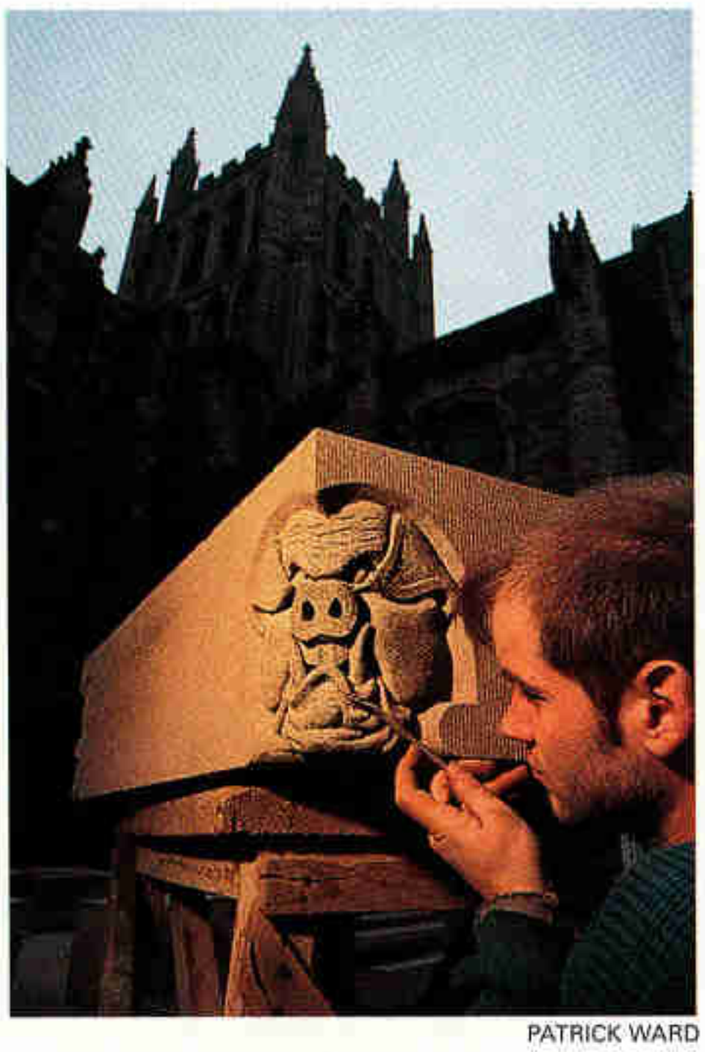
New dating has revealed that a crater in France called Rochechouart, 15 miles in diameter, was formed about 214 million years ago. John G. Spray of the University of New Brunswick realized that this was the same time that eastern Canada's Manicouagan (above), 60 miles in diameter, took shape. Poring over a list of known craters, he and his team found a third big one, in Manitoba, the same age.

When they mapped Earth as it was at that time (above left), the craters lined up at the same latitude in a chain nearly 2,800 miles long. Two smaller craters may have been caused by fragments of the same heavenly body.

These Little Piggies Will Live Forever

First they escaped the butcher's cleaver. Now a more benign tool, the carver's chisel, has immortalized them.

The pair of Tamworth pigs—a breed prized for its bacon—fled a slaughterhouse in Malmesbury, England, early this year. They led workers, police, and animal welfare advocates on a merry chase over a river and through the woods for a week before they were cornered, sedated by tranquilizer darts, and recaptured. The English press christened them Butch and Sundance and feverishly chronicled their exploits. Finally a tabloid bought the pair of piggies that wouldn't stay home and installed them in an animal sanctuary.



PATRICK WARD

The saga led stone carver Andy Frayling, creating fanciful figures called grotesques for the restoration of a 13th-century chapel in Hereford Cathedral, to memorialize Butch (above) and Sundance in stone. He also carved a butcher disconsolate over losing his pig.



RICHARD SCHULTZ

America's First Domestic Sheep Mark a Milestone

Four hundred years ago this year, Spanish colonists imported churro sheep like these to the Southwest U.S. They soon became popular with the Navajo for wool and meat. But government action in 19th-century Indian wars and 20th-century anti-erosion efforts decimated flocks; by the 1970s a peak of perhaps two million had dwindled to fewer than 450.

Lyle McNeal of Utah State University then began efforts to revive the breed. It now numbers more than 3,000 and is favored by weavers on and off Navajo land. "It's endured," says Connie Taylor of the Navajo-Churro Sheep Association, "but so have the Navajo and their culture."

A pill that helps men with erectile dysfunction respond again.



Naturally, the response has been positive.

Now there's a simple new pill for the treatment of erectile dysfunction (a common medical problem also called impotence).

VIAGRA® (sildenafil citrate) is a prescription pill that may help you achieve erections the natural way—in response to sexual stimulation. Ask your doctor if VIAGRA is the right step for you.

VIAGRA should not be taken by men who use drugs known as nitrates (most often used to control angina) in any form, at any time. Nitrates can reduce blood pressure to unsafe levels if used with VIAGRA. Be sure to talk to your doctor about any medications you take.

In clinical trials, VIAGRA was well tolerated. Some men experienced side effects, including headache, facial flushing, and upset stomach. A small percentage of men experienced mild and temporary visual effects. (See product information for more details.)

For more information, call 1-888-4VIAGRA or visit www.viagra.com.

VIAGRA®
(sildenafil citrate) tablets
Let the dance begin.

Please see brief summary of product information for VIAGRA (25-mg, 50-mg, 100-mg) tablets on the following page.

Let the dance begin.



Brief summary of prescribing information

VIAGRA®
(sildenafil citrate) tablets

INDICATION AND USAGE

VIAGRA is indicated for the treatment of erectile dysfunction. The studies that established benefit demonstrated improvements in success rates for sexual intercourse compared with placebo.

CONTRAINDICATIONS

Use of VIAGRA is contraindicated in patients with a known hypersensitivity to any component of the tablet. Consistent with its known effects on the nitric oxide/cGMP pathway (see CLINICAL PHARMACOLOGY), **VIAGRA was shown to potentiate the hypotensive effects of nitrates, and its administration to patients who are concurrently using organic nitrates in any form is therefore contraindicated.**

PRECAUTIONS

General

A thorough medical history and physical examination should be undertaken to diagnose erectile dysfunction, determine potential underlying causes, and identify appropriate treatment.

There is a degree of cardiac risk associated with sexual activity; therefore, physicians may wish to consider the cardiovascular status of their patients prior to initiating any treatment for erectile dysfunction.

Agents for the treatment of erectile dysfunction should be used with caution in patients with anatomical deformation of the penis (such as angulation, cavernosal fibrosis or Peyronie's disease), or in patients who have conditions which may predispose them to priapism (such as sickle cell anemia, multiple myeloma, or leukemia).

The safety and efficacy of combinations of VIAGRA with other treatments for erectile dysfunction have not been studied. Therefore, the use of such combinations is not recommended.

VIAGRA has no effect on bleeding time when taken alone or with aspirin. *In vitro* studies with human platelets indicate that sildenafil potentiates the antiaggregatory effect of sodium nitroprusside (a nitric oxide donor). There is no safety information on the administration of VIAGRA to patients with bleeding disorders or active peptic ulceration. Therefore, VIAGRA should be administered with caution to these patients.

A minority of patients with the inherited condition retinitis pigmentosa have genetic disorders of retinal phosphodiesterases. There is no safety information on the administration of VIAGRA to patients with retinitis pigmentosa. Therefore, VIAGRA should be administered with caution to these patients.

Information for Patients

Physicians should discuss with patients the contraindication of VIAGRA with concurrent organic nitrates.

The use of VIAGRA offers no protection against sexually transmitted diseases. Counseling of patients about the protective measures necessary to guard against sexually transmitted diseases, including the Human Immunodeficiency Virus (HIV), may be considered.

Drug Interactions

Effects of Other Drugs on VIAGRA

***In vitro* studies:** Sildenafil metabolism is principally mediated by the cytochrome P450 (CYP) isoforms 3A4 (major route) and 2C9 (minor route). Therefore, inhibitors of these isoenzymes may reduce sildenafil clearance.

***In vivo* studies:** Cimetidine (800 mg), a non-specific CYP inhibitor, caused a 56% increase in plasma sildenafil concentrations when co-administered with VIAGRA (50 mg) to healthy volunteers.

When a single 100 mg dose of VIAGRA was administered with erythromycin, a specific CYP3A4 inhibitor, at steady state (500 mg bid for 5 days), there was a 182% increase in sildenafil systemic exposure (AUC). Stronger CYP3A4 inhibitors such as ketoconazole, itraconazole or mibefradil would be expected to have still greater effects, and population data from patients in clinical trials did indicate a reduction in sildenafil clearance when it was co-administered with CYP3A4 inhibitors (such as ketoconazole, erythromycin, or cimetidine). It can be expected that concomitant administration of CYP3A4 inducers, such as rifampin, will decrease plasma levels of sildenafil.

Single doses of antacid (magnesium hydroxide/aluminum hydroxide) did not affect the bioavailability of VIAGRA.

Pharmacokinetic data from patients in clinical trials showed no effect on sildenafil pharmacokinetics of CYP2C9 inhibitors (such as tolbutamide, warfarin), CYP2D6 inhibitors (such as selective serotonin reuptake inhibitors, tricyclic antidepressants), thiazide and related diuretics, ACE inhibitors, and calcium channel blockers. The AUC of the active metabolite, N-desmethyl sildenafil, was increased 62% by loop and potassium-sparing diuretics and 102% by non-specific beta-blockers. These effects on the metabolite are not expected to be of clinical consequence.

Effects of VIAGRA on Other Drugs

***In vitro* studies:** Sildenafil is a weak inhibitor of the cytochrome P450 isoforms 1A2, 2C9, 2C19, 2D6, 2E1 and 3A4 (IC50 > 150 μM). Given sildenafil peak plasma concentrations of approximately 1 μM after recommended doses, it is unlikely that VIAGRA will alter the clearance of substrates of these isoenzymes.

***In vivo* studies:** No significant interactions were shown with tolbutamide (250 mg) or warfarin (40 mg), both of which are metabolized by CYP2C9.

VIAGRA (50 mg) did not potentiate the increase in bleeding time caused by aspirin (150 mg).

VIAGRA (50 mg) did not potentiate the hypotensive effect of alcohol in healthy volunteers with mean maximum blood alcohol levels of 0.08%.

No interaction was seen when VIAGRA (100 mg) was co-administered with amlodipine in hypertensive patients. The mean additional reduction on supine blood pressure (systolic, 8 mmHg; diastolic, 7 mmHg) was of a similar magnitude to that seen when VIAGRA was administered alone to healthy volunteers (see CLINICAL PHARMACOLOGY).

Analysis of the safety database showed no difference in the side effect profile in patients taking VIAGRA with and without anti-hypertensive medication.

Carcinogenesis, Mutagenesis, Impairment of Fertility

Sildenafil was not carcinogenic when administered to rats for 24 months at a dose resulting in total systemic drug exposure (AUCs) for unbound sildenafil and its major metabolite of 29- and 42-times, for male and female rats, respectively, the exposures observed in human males given the Maximum Recommended Human Dose (MRHD) of 100 mg. Sildenafil was not carcinogenic when administered to mice for 18-21 months at dosages up to the Maximum Tolerated Dose (MTD) of 10 mg/kg/day, approximately 0.6 times the MRHD on a mg/m² basis.

Sildenafil was negative in *in vitro* bacterial and Chinese hamster ovary cell assays to detect mutagenicity, and *in vitro* human lymphocytes and *in vivo* mouse micronucleus assays to detect clastogenicity.

There was no impairment of fertility in rats given sildenafil up to 60 mg/kg/day for 36 days to females and 102 days to males, a dose producing an AUC value of more than 25 times the human male AUC.

There was no effect on sperm motility or morphology after single 100 mg oral doses of VIAGRA in healthy volunteers.

Pregnancy, Nursing Mothers and Pediatric Use

VIAGRA is not indicated for use in newborns, children, or women.

Pregnancy Category B. No evidence of teratogenicity, embryotoxicity or fetotoxicity was observed in rats and rabbits which received up to 200 mg/kg/day during organogenesis. These doses represent, respectively, about 20 and 40 times the MRHD on a mg/m² basis in a 50 kg subject. In the rat pre- and postnatal development study, the no observed adverse effect dose was 30 mg/kg/day given for 36 days. In non-pregnant rats the AUC at this dose was about 20 times human AUC. There are no adequate and well-controlled studies of sildenafil in pregnant women.

ADVERSE REACTIONS

VIAGRA was administered to over 3700 patients (aged 19-87 years) during clinical trials worldwide. Over 550 patients were treated for longer than one year.

In placebo-controlled clinical studies, the discontinuation rate due to adverse events for VIAGRA (2.5%) was not significantly different from placebo (2.3%). The adverse events were generally transient and mild to moderate in nature.

In trials of all designs, adverse events reported by patients receiving VIAGRA were generally similar. In fixed-dose studies, the incidence of some adverse events increased with dose. The nature of the adverse events in flexible-dose studies, which more closely reflect the recommended dosage regimen, was similar to that for fixed-dose studies.

When VIAGRA was taken as recommended (on an as-needed basis) in flexible-dose, placebo-controlled clinical trials the following adverse events were reported:

TABLE 1. ADVERSE EVENTS REPORTED BY ≥2% OF PATIENTS TREATED WITH VIAGRA AND MORE FREQUENT ON DRUG THAN PLACEBO IN PRN FLEXIBLE-DOSE PHASE II/III STUDIES

Adverse Event	Percentage of Patients Reporting Event	
	VIAGRA N=734	PLACEBO N=725
Headache	16%	4%
Flushing	10%	1%
Dyspepsia	7%	2%
Nasal Congestion	4%	2%
Urinary Tract Infection	3%	2%
Abnormal Vision*	3%	0%
Diarrhea	3%	1%
Dizziness	2%	1%
Rash	2%	1%

*Abnormal Vision: Mild and transient, predominantly color tinge to vision, but also increased sensitivity to light or blurred vision. In these studies, only one patient discontinued due to abnormal vision.

Other adverse reactions occurred at a rate of >2%,but equally common on placebo: respiratory tract infection, back pain, flu syndrome, and arthralgia.

In fixed-dose studies, dyspepsia (17%) and abnormal vision (11%) were more common at 100 mg than at lower doses. At doses above the recommended dose range, adverse events were similar to those detailed above but generally were reported more frequently.

No cases of priapism were reported.

The following events occurred in < 2% of patients in controlled clinical trials; a causal relationship to VIAGRA is uncertain. Reported events include those with a plausible relation to drug use; omitted are minor events and reports too imprecise to be meaningful:

Body as a whole: face edema, photosensitivity reaction, shock, asthenia, pain, chills, accidental fall, abdominal pain, allergic reaction, chest pain, accidental injury.

Cardiovascular: angina pectoris, AV block, migraine, syncope, tachycardia, palpitation, hypotension, postural hypotension, myocardial ischemia, cerebral thrombosis, cardiac arrest, heart failure, abnormal electrocardiogram, cardiomyopathy.

Digestive: vomiting, glossitis, colitis, dysphagia, gastritis, gastroenteritis, esophagitis, stomatitis, dry mouth, liver function tests abnormal, rectal hemorrhage, gingivitis.

Hemic and Lymphatic: anemia and leukopenia.

Metabolic and Nutritional: thirst, edema, gout, unstable diabetes, hyperglycemia, peripheral edema, hyperuricemia, hypoglycemic reaction, hypernatremia.

Musculoskeletal: arthritis, arthrosis, myalgia, tendon rupture, tenosynovitis, bone pain, myasthenia, synovitis.

Nervous: ataxia, hypertonia, neuralgia, neuropathy, paresthesia, tremor, vertigo, depression, insomnia, somnolence, abnormal dreams, reflexes decreased, hypesthesia.

Respiratory: asthma, dyspnea, laryngitis, pharyngitis, sinusitis, bronchitis, sputum increased, cough increased.

Skin and appendages: urticaria, herpes simplex, pruritus, sweating, skin ulcer, contact dermatitis, exfoliative dermatitis.

Special senses: mydriasis, conjunctivitis, photophobia, tinnitus, eye pain, deafness, ear pain, eye hemorrhage, cataract, dry eyes.

Urogenital: cystitis, nocturia, urinary frequency, breast enlargement, urinary incontinence, abnormal ejaculation, genital edema and anorgasmia.

OVERDOSAGE

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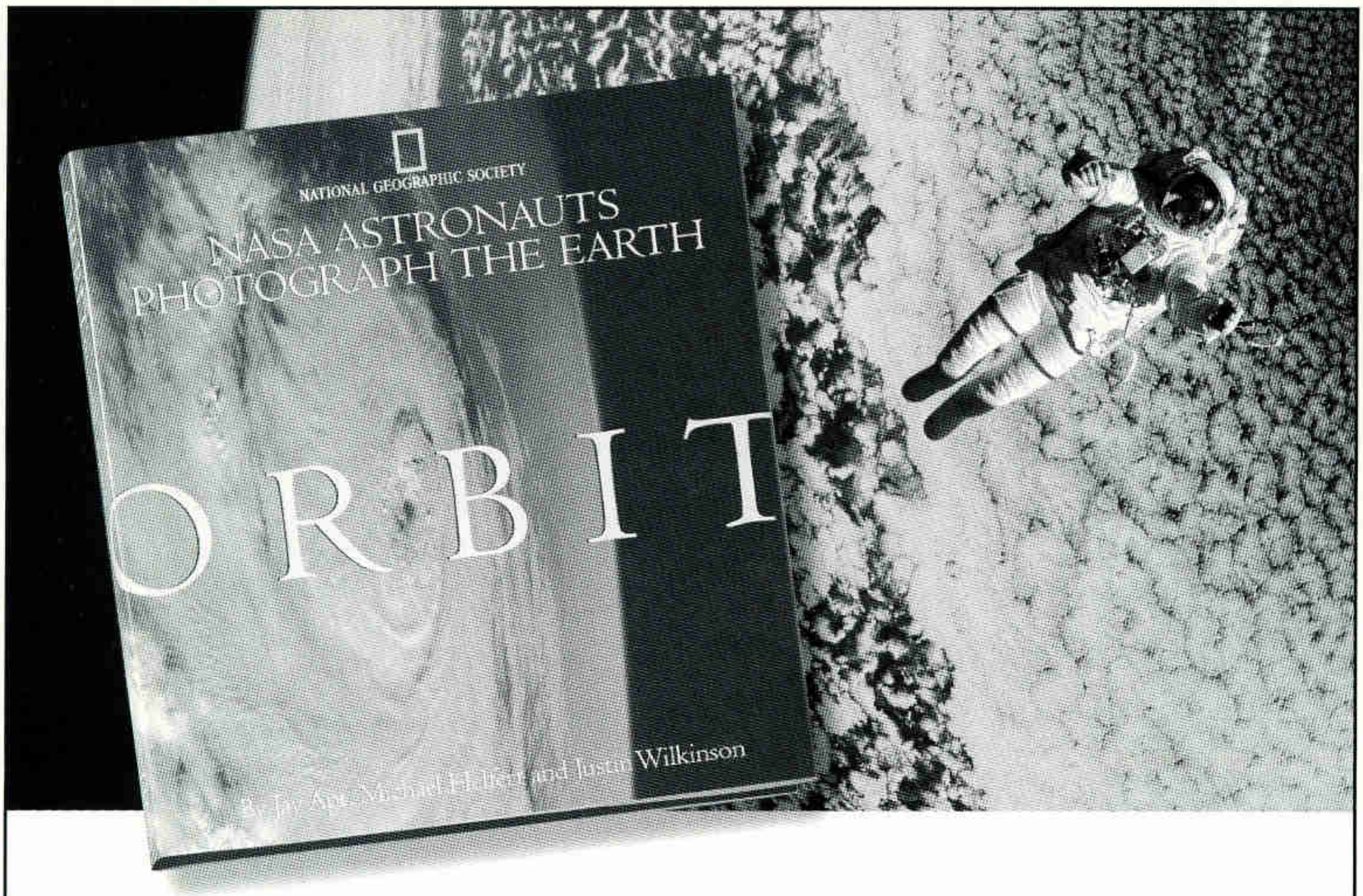
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Life at the Top in a Mesopotamian Kingdom

The king was named Tupkish, his queen Uqnitum. More than 4,000 years ago they ruled the fabled capital of Urkesh, which controlled vital copper trade routes in what is now northeastern Syria.

Working beneath a canvas to protect themselves from the blazing summer sun, excavators at Tell Mozan (top) are uncovering a royal storehouse attached to a large building. Archaeologists Giorgio Buccellati and Marilyn Kelly-Buccellati, who have studied the 330-acre site (above right) since 1984, identified it as Urkesh in 1995. Now they believe the building may turn out to be a royal palace, home to Tupkish, Uqnitum, and their court.

"It will take a throne room or fancy residential quarters to prove it," says Buccellati, a UCLA professor. "We hoped to determine that last year, but the building turned out to be bigger than anticipated."

The storehouse and nearby houses have yielded a wealth of information—including the names of the two royals—notably from more than 200 impressions made by seals on an array of containers.

Last year's finds included a cuneiform tablet (above left) whose text, listing a shipment of goods, mentions a copper dagger similar to the spearhead at left. Excavators also unearthed 300 intriguing animal figurines, such as this clay horse (below) less than two inches long, whose purpose is unknown.

TEXT BY BORIS WEINTRAUB



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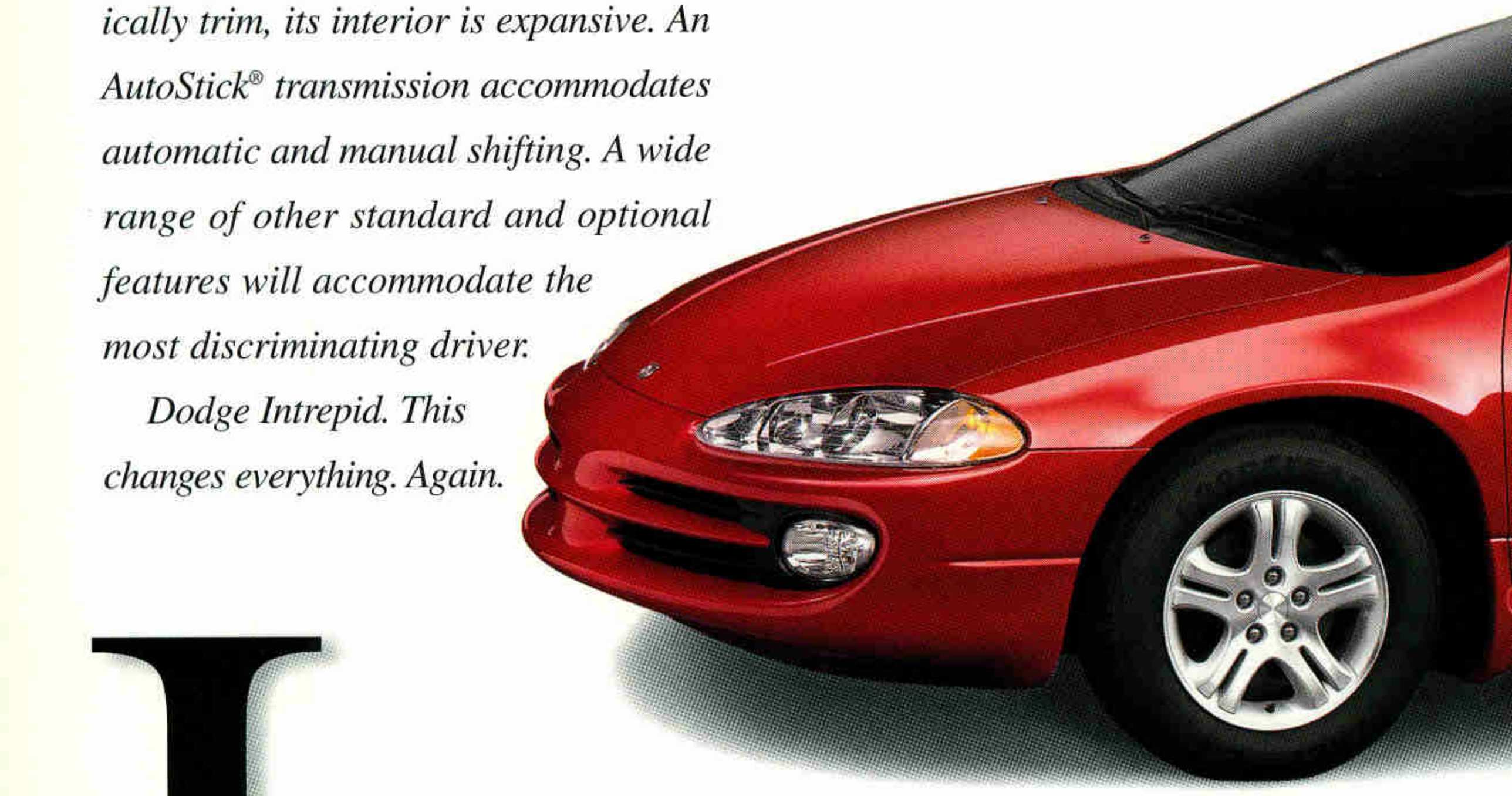
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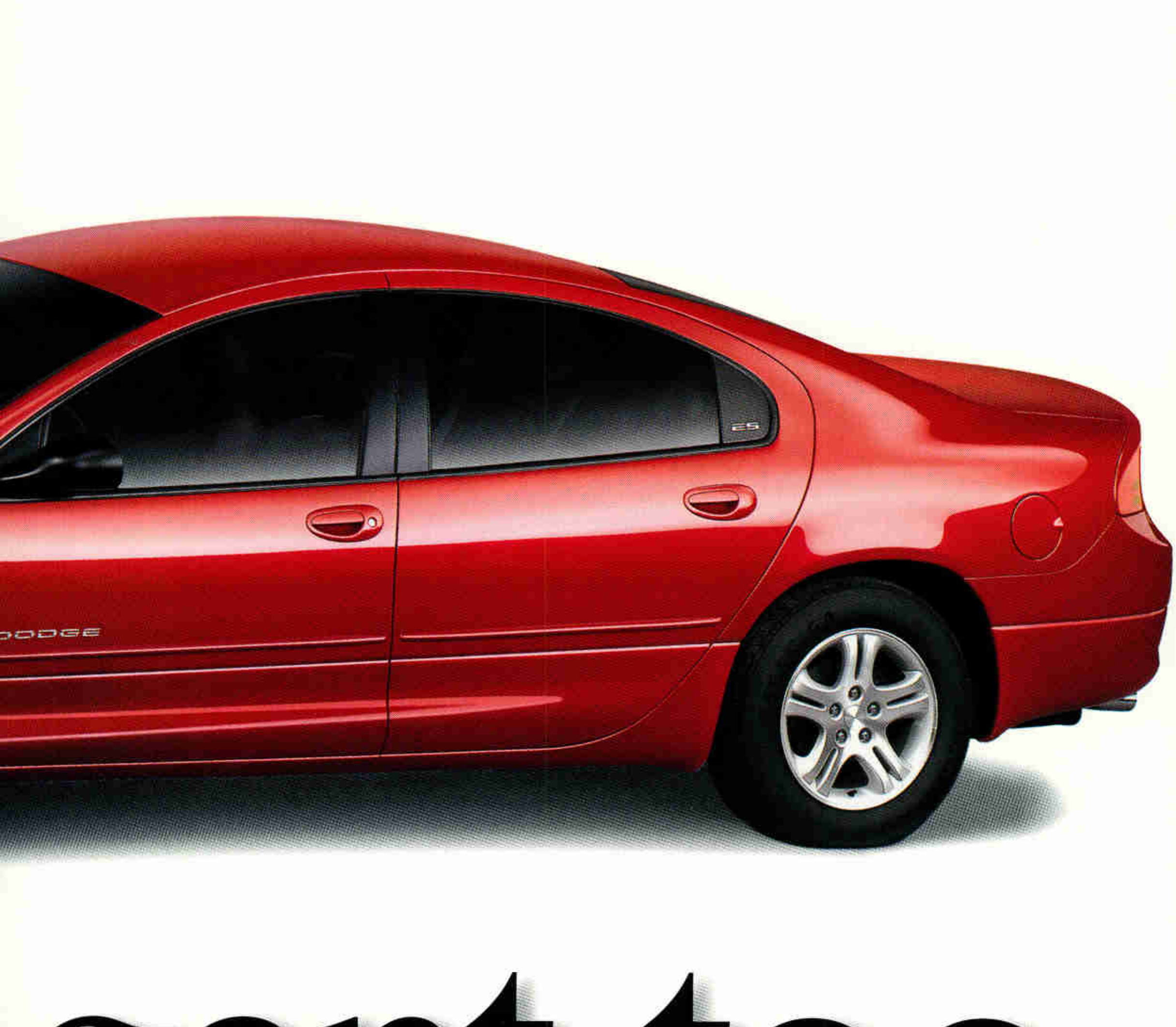


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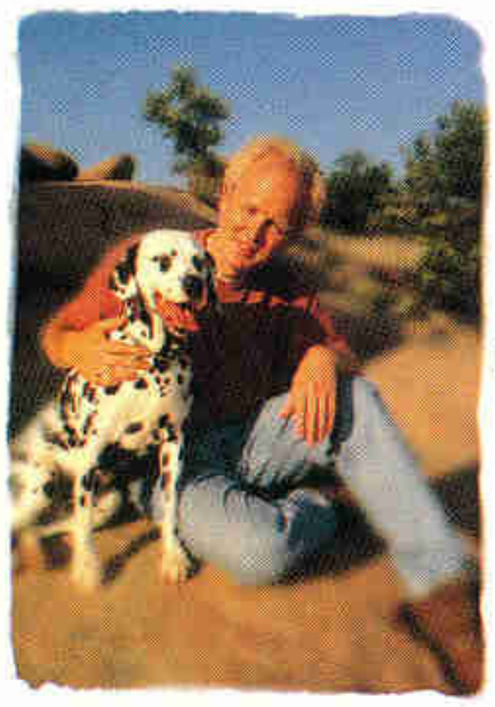
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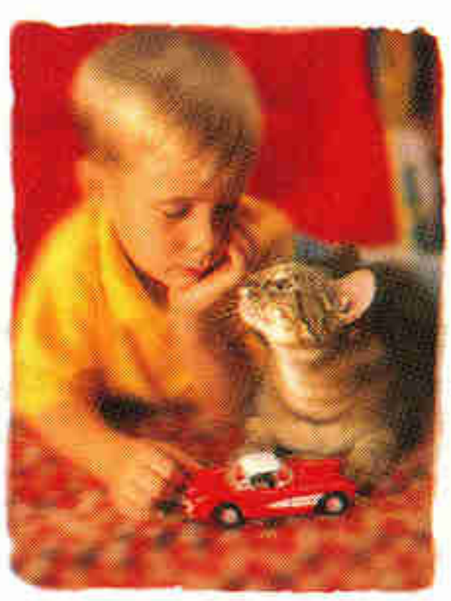


gent, too.

I wish  *my dog didn't scratch so much.*

I wish my cat  *didn't shed so much.*

I wish my dog  *would live until my kids are grown.*

I wish my older cat  *was more playful.*

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NATIONAL GEOGRAPHIC

From the Editor



KAREN KASMAUSKI

EVERY TEN SECONDS the world's population increases by 27 people. That's not a conjured-up scare statistic. It's just a statement of fact, according to the Population Reference Bureau. With luck those 27 people will have enough food to eat and clean water to drink and will dwell in decent homes. They will become farmers, teachers, salespeople, and magazine editors. If all goes well, they will live to a ripe old age.

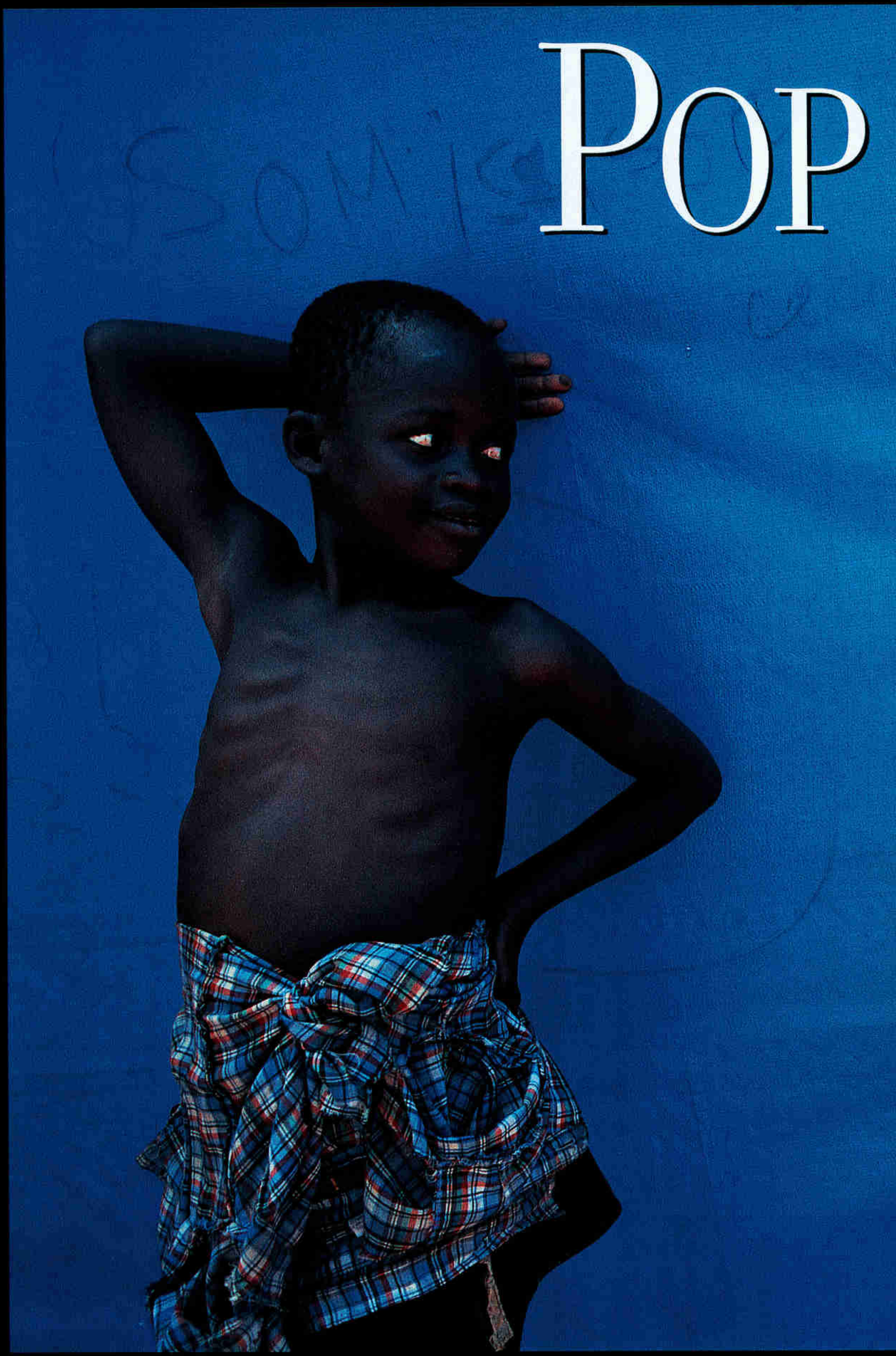
They will also clear forests for agriculture and housing, generate bargefuls of sewage, and choke rivers with fertilizer runoff. And therein lies the challenge of balancing world population growth with our planet's biodiversity.

Our millennium coverage continues this month with a series of articles addressing population. The first tackles the issue of human migration. People have long sought to spread out from their places of origin, whether they crossed a land bridge from Asia to North America, boarded wooden ships westbound from Europe, or pushed through the vast forests, deserts, and mountain ranges of Africa. Wherever they've roamed, women, as the bearers and traditional nurturers of children, have faced their share of hardship. In "Women and Population" we explore the status of women as a critical factor in population issues. Finally there is the matter of feeding the 5.9 billion people living today and the billions more that the Earth will have to support in the decades to come.

In a forthcoming issue we will examine global biodiversity and how we can attain a sustainable relationship with the plants and animals with which we share our increasingly crowded planet.

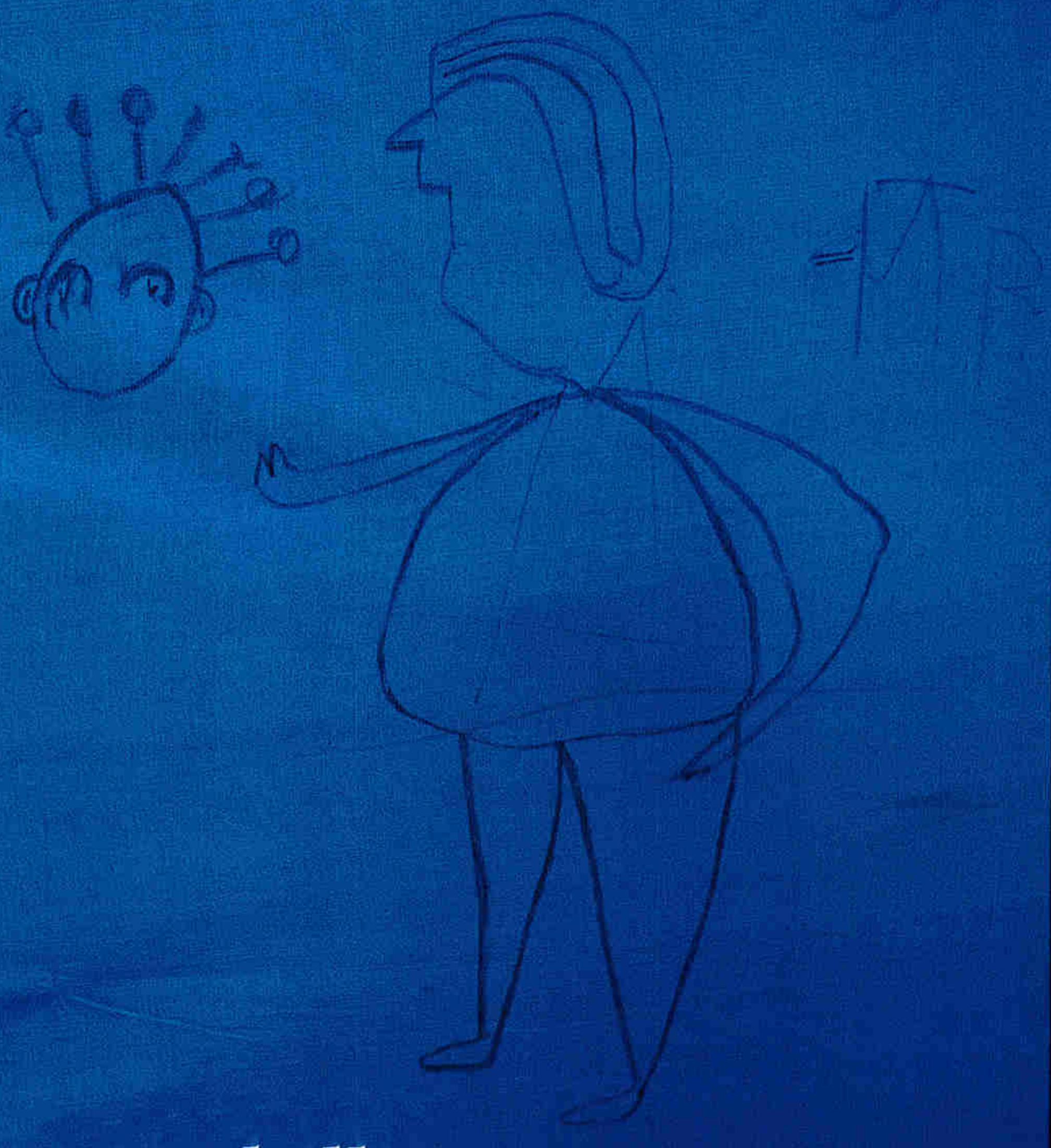
Bill Allen

Pop



By **Joel L. Swerdlow** ASSISTANT EDITOR

ULATION



One in six billion

■ **An African refugee, part of a recent wave of migration, grows up in a paradoxical world of falling birthrates and soaring human numbers, record harvests and widespread hunger.**

KAREN KASMAUSKI



The millennium series spotlights six subjects shaping human destiny. Articles in the February 1999 issue will focus on biodiversity.

It takes only 12 years or so to add

OF ALL THE ISSUES WE FACE as the new millennium nears, none is more important than population growth. The numbers speak for themselves. Earth's population, which totaled 1.7 billion people in 1900, is now nearly 6 billion—and growing. ■ But when I talk about this issue, someone invariably asks, "How can there be a population problem when so much land is empty?" It's a logical question. If everyone on Earth moved to Texas, we'd each have about 1,200 square feet of living space. The rural heartland of the United States is, in fact, emptying out as farming becomes more mechanized. ■ I have a personal tie to this empty zone. In 1905 my grandfather left Russia for Logan County, North Dakota, seeking opportunity and freedom from oppression. Virtually all of us, as Michael Parfit points out in "Human Migration," have such journeys in our family history. ■ My father was born in a sod hut in 1909, and his family left North Dakota for Bayonne, New Jersey, in 1918, part of the rural-to-urban shift that is reshaping the world. When my father was young, almost 90 percent of the world's people lived in the countryside. Now nearly half live in cities. ■ Logan County's population peaked in 1930 at 8,100 people. It's now below 2,500. Abandoned farmhouses and barns dot the landscape. ■ "I'm 47 and one of the youngest people active in my community," says Randy Mundt, a banker in Wishek, the neighboring McIntosh County town where my father attended school. "There's no next generation for me to hand community responsibilities over to because young people are moving away." A shortage of people isn't only a concern in rural areas. Lower birthrates contribute to an expected drop in the populations of Japan and Western Europe. ■ Declining population? Since long before Paul Ehrlich's 1968 book, *The Population Bomb,* haven't experts warned of mass starvation? Such predictions did not anticipate the new plant varieties and technological advances of recent decades that have boosted yields of wheat and maize, for example, by nearly 80 percent. And by 1970 global population growth rates had peaked. ■ As Erla Zwingle explains in "Women and Population," birthrates abate as women gain access to contraceptives, health care, education, and economic opportunities. Today 98 percent of growth occurs in the developing world—where these benefits are least available.

another billion people to the population.

—WOLFGANG LUTZ, DEMOGRAPHER

■ By raising awareness, experts' dire predictions may have helped slow population growth. But the crisis, or at least the potential crisis, has not disappeared. We have no guarantees that a population rise that outstrips food and water supplies does not await us—the United Nations' highest current projection is 11 billion people by 2050. ■ Curtailing overall numbers, furthermore, does not solve all population problems. As we become more urban and industrial, we consume more resources and generate more pollution. China, whose cities now hold 350 million people, has lost 20 percent of its arable land since the late 1950s. What further environmental damage—and social unrest—could occur as Chinese crowd into cities? ■ In "Feeding the Planet" T. R. Reid concludes that the chief problem isn't our capacity to produce food but rather how food is distributed. His article highlights an ongoing debate. Optimists point out that a crisis is not inevitable. Technological innovation, they say, will always keep food supply a step ahead of population. Pessimists warn that we can't count on technological fixes to rescue us from population problems. By changing the environment, moreover, agricultural technology itself contributes to problems, such as loss of biodiversity, that are likely to worsen as our numbers increase. ■ Concerns about overpopulation seem far away as I drive through Wishek, North Dakota, which is so small it has no traffic light. Wishek Steel and Manufacturing catches my eye. ■ Owners Harley and Carol Brandner, once local wheat farmers, explain that they started a welding repair shop here in 1969 and then patented "a spring action in which a whole section of discs rises when it hits a rock," making it easier to cultivate hard, stony soil. This invention is now at work in the Hulun Buir grasslands of Inner Mongolia. Overgrazed and prone to erosion, that faraway barren area will soon yield alfalfa. ■ The Brandners' tiller seems perfect for the land my grandfather often called "rough and hard." Following an old county map I drive along dirt roads, searching for his farm. Wheat fields surround me. I find the family homestead, which I am surprised to see is now a federal wildlife management area. Meadowlarks nest in knee-high grass. ■ Standing where my father was born makes the land come alive. Will we have the wisdom, it seems to ask, to live in balance with the natural world as we grapple with the needs of our growing population? □

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THE MILLENNIUM SERIES

Human Migration

BY MICHAEL PARFIT PHOTOGRAPHS BY KAREN KASMAUSKI



■ Leaving home to dwell in an unfamiliar world—more than a million rural Bangladeshis have done it, seeking jobs in Dhaka (below). So too have tens of millions of others, whose movements endlessly transform the planet's human face.

Heading home, refugees load their possessions on a ferry that will take them from Tanzania across Lake Tanganyika to the Democratic Republic of the Congo. Conflict in central Africa has fueled the growth of the world's refugee population, which has mushroomed from two million



people in the mid-1960s to 15 million people today. "That's a significant number, but refugee counts ebb and flow," says demographer Charles Keely, who cites the late 1940s as an even more tumultuous time. "It's been better," he says, "and worse."

Behind the relatively stable appearance of

WHAT CHUCK JUHN noticed most was the quietness. The road was full of people, but there were no voices. Hundreds of people—thousands—walked past him. This many voices would make a football stadium thunder. But they were silent.

They just walked, so many people that they filled the road, edge to edge, as far as Juhn could see, and all he heard was the soft, weary whisper of feet on the road. The people used every last scrap of energy just to keep moving.

"People at the margin don't mess around," remembered Juhn, an American aid worker who was in Rwanda at the time. "They didn't say a word. Total silence. They were so washed out and skinny; it was like some other reality moving through."

Juhn was watching one of the great single movements of people in recent years. It happened in December 1996. It was the sudden

Pondering his next move, José Alonzo peers under a fence at the U.S.-Mexico border in Tijuana. His first attempt to sneak into the U.S. failed. Now, like countless of his countrymen, he waits for an opening to dash north, get a job—and then lie low.

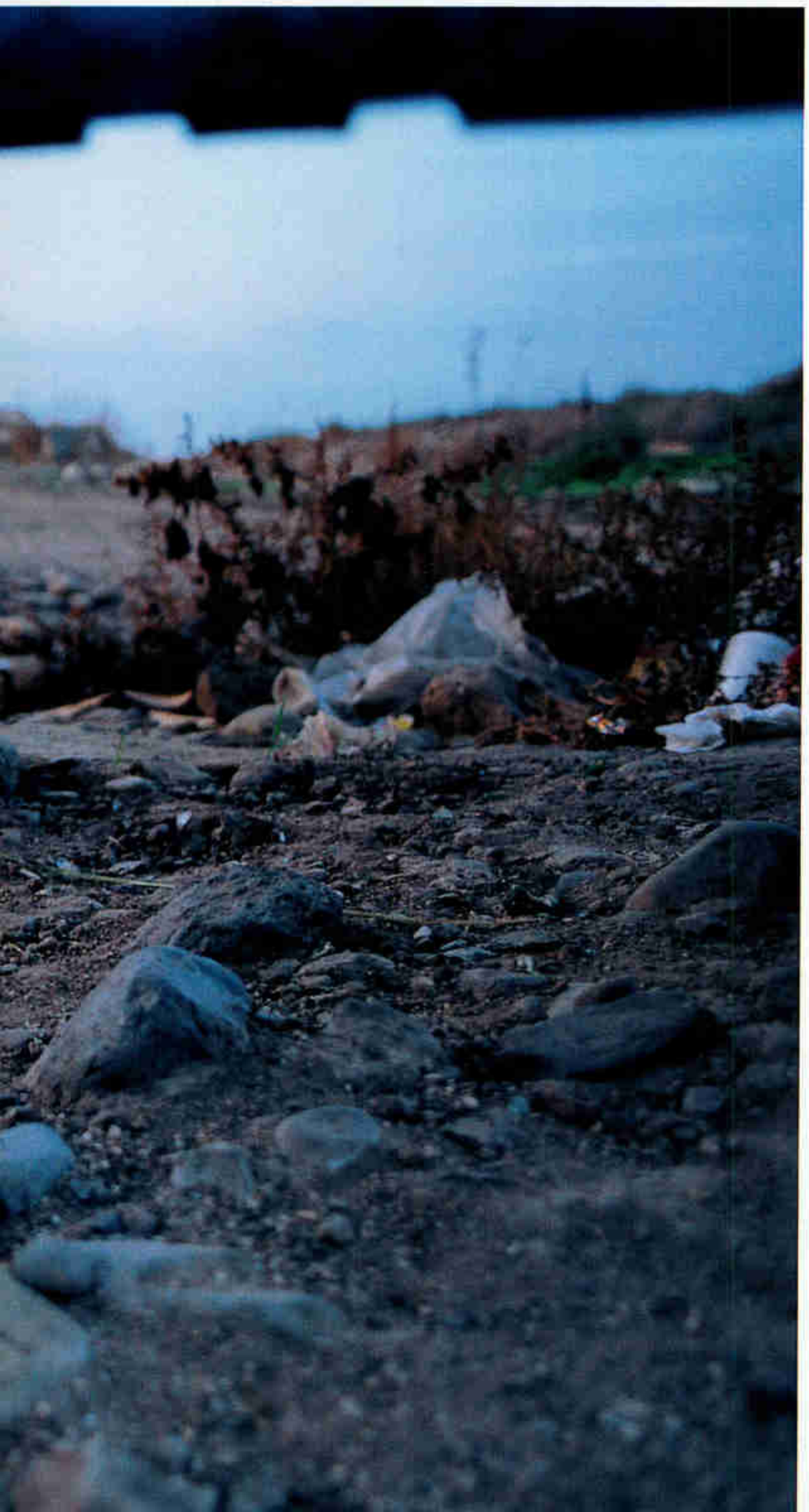


the world, people are moving, quietly.

return of more than 450,000 Rwandan refugees from camps in Tanzania to their home country after the brutal upheavals of 1994 and '95. Forced out of Tanzania by government deadlines, the refugees left the huge camps in less than a week and started walking home.

"I'm glad I saw it," said Juhn, when I talked to him recently in Tanzania, "but I don't ever want to see something like that again."

He may not—movements of thousands of people seldom occur so suddenly, or so visibly. But something like this happens every day. Behind the relatively stable appearance of much of the world, the same kinds of numbers are moving, almost as quietly. In airports and seaports and railway stations, along forested borders, and even where steel and barbed wire make barriers that seem impenetrable, thousands upon thousands of people are on their way to somewhere new. They don't make much noise, but they change the world.



Human migration: The term is vague. What people usually think of is the permanent movement of people from one home to another. More broadly, though, migration means all the ways—from the seasonal drift of agricultural workers within a country to the relocation of refugees from one country to another—in which people slake the fever or need to move.

Migration is big, dangerous, compelling. It's Exodus, Ulysses, the Battle of Agincourt, Viking ships on the high seas bound for Iceland, slave ships and civil war, the secret movement of Jewish refugees through occupied lands during World War II. It is 60 million Europeans leaving home from the 16th to the 20th centuries. It is some 15 million Hindus, Sikhs, and Muslims swept up in a tumultuous shuffle of citizens between India and Pakistan after the partition of the subcontinent in 1947.

Migration is the dynamic undertow of population change; everyone's solution, everyone's conflict. As the century turns, migration, with its inevitable economic and political turmoils, has been called "one of the greatest challenges of the coming century."

But it is much more than that. It is, as it has always been, the great adventure of human life. Migration helped create humans, drove us to conquer the planet, shaped our societies, and promises to reshape them again.

"YOU HAVE A HISTORY book written in your genes," said Spencer Wells. The book he's trying to read goes back to long before even the first word was written, and it is a story of migration.

Wells, a tall, blond geneticist at Stanford University, spent the summer of 1998 exploring remote parts of Transcaucasia and Central Asia

Running out of room at the U.S. border, Tijuana attracts Mexicans who move there for jobs and for a chance to head north some day. Lax security here in the late 1980s and early '90s emboldened a steady stream of illegal migrants, prompting the U.S. Immigration and Naturalization



Service to launch Operation Gatekeeper in 1994. The program beefed up border patrols and stanched much of the illegal influx, but it failed to dissuade those tough enough to travel farther east, where they make a run for it across less populated and more dangerous terrain.

with three colleagues in a Land Rover, looking for drops of blood. In the blood, donated by the people he met, he will search for the story that genetic markers can tell of the long paths human life has taken across the Earth.

Genetic studies are the latest technique in a long effort of modern humans to find out where they have come from. But however the paths are traced, the basic story is simple: People have been moving since they were people. If early humans hadn't moved and intermingled as much as they did, they probably would have continued to evolve into different species. From beginnings in Africa, most researchers agree, groups of hunter-gatherers spread out, driven to the ends of the Earth.

To demographer Kingsley Davis, two things made migration happen: First, human beings, with their tools and language, could adapt to different conditions without having to wait for evolution to make them suitable for a new niche. Second, as populations grew, cultures began to differ, and inequalities developed between groups. The first factor gave us the keys to the door of any room on the planet; the other gave us reasons to use them.

Over the centuries, as agriculture spread across the planet, people moved toward places where metal was found and worked and to centers of commerce that then became cities. Those places were, in turn, invaded and overrun by people later generations called barbarians. The names of some of these groups have become symbols of upheaval: Hittites, Scythians, Visigoths, Vandals, and, lest we forget, Attila's vigorous warriors, the Huns.

In between these storm surges were steadier but similarly profound tides in which people moved out to colonize or were captured and brought in as slaves. For a while the population of Athens, that city of legendary enlightenment, was as much as 35 percent slaves.

"What strikes me is how important migration is as a cause and effect in the great world events," Mark J. Miller, co-author of *The Age of Migration* and a professor of political science at the University of Delaware, told me recently.



It is difficult to think of any great events that did not involve migration. Religions spawned pilgrims or settlers; wars drove refugees before them and made new land available for the conquerors; political upheavals displaced thousands or millions; economic innovations drew workers and entrepreneurs like magnets; environmental disasters like famine or disease pushed their bedraggled survivors anywhere they could replant hope.

"It's part of our nature, this movement," Miller said. "It's just a fact of the human condition."

What drives this fact of nature, and how is it likely to change humans next? Over the past months I met a lot of people who were in various stages of migration. Without exception they were kind and gentle people. But the forces that drove them were ruthless.

No stranger to migration, MICHAEL PARFIT was born in England and raised in Michigan, Connecticut, California, and Brazil; he now resides in Montana. While growing up in a military family, KAREN KASMAUSKI moved frequently; today Virginia is home.



Persecuted for their faith, Mormons were forced to leave Missouri by order of the governor in 1838. By 1846 many Mormons had embarked on a harrowing 1,300-mile trek west from Illinois to present-day Utah, a migration recently re-enacted by the faithful (above).

"IT WAS DURING the nighttime when the soldiers came," said my interpreter, Muhammad. "They started to kill people; I mean shooting. And some of [the refugees'] relatives were killed. Yes, some of their family were killed."

I was in an enclosure on the Tanzanian shore of Lake Tanganyika. The roof was a blue tarp, printed UNHCR: United Nations High Commissioner for Refugees. The UNHCR has programs in over a hundred countries and in 1997 had a role in the lives of 22 million people.

About 20 refugees from the small African nation of Burundi, which adjoins Tanzania to the northwest, sat inside. The day before they had come to this receiving center by boat down the coast of Lake Tanganyika. Among them was a refugee who told Muhammad in Swahili what had happened just a few days earlier.

He spoke impassively, as if explaining a machine. Beside him sat his wife and baby. He was 20; his wife was 18. The child was 9 months old and had sores all over his scalp.

"This man was with his parents there," Muhammad explained. "Up to this moment he does not know whether his parents are alive or if they were killed. For seven days they are walking, coming to this country."

I did not know what to say. The refugee looked at me without emotion, as if to say: This

is too serious for sympathy. Twenty other pairs of eyes in the enclosure looked at me calmly and said the same thing.

"For you, shocking," said Muhammad. "But for us, not, because this we are hearing day and night."

A ledger kept here by the organization Chuck Juhn worked for, the International Rescue Committee, told a brutal story of the health of the incoming refugees: Malaria, dislocated shoulder, malaria, bullet wound, bullet, bullet, bullet, multiple bullet.

Scholars call this "forced migration." Most of the 20 million or more people a year who are involved with the UNHCR are fleeing from conflict. The number fluctuates widely. In 1991 it was 17 million; it grew to 27 million in 1995 and declined to 22 million in 1997.

These numbers are hard to visualize, but I will always find it very easy to see in my mind's eye the little family from Burundi sitting on a straw mat in the UNHCR reception center, waiting for a ration of high-energy biscuits and looking at me with that strange serenity, while Muhammad explained how they had kept themselves going, day after day, walking through the bush to get here:

"The hunger has been forcing them to walk," Muhammad said. "Besides that—the peace."

A SIMPLE EXPLANATION for migration is that one place pulls on a person, with good wages, freedom, land, or peace, while the place in which the person lives pushes because of low incomes, repression, overcrowding, or war. Mark Miller urged me not to fall for such appealing simplicity. Migration, Miller argues, is not a matter of each individual deciding rationally and simply where the best hope for freedom or success lies. It is much more complicated and involves each person's history, beliefs, and family; his country's prior relationships with other nations; and the whole interlocking international web of existing migration routes and patterns.

However, push-and-pull factors, like the war in Burundi and the peace in Tanzania, are unquestionably part of the equation. I saw another part of the push and pull clearly in the United States and Mexico, where economics was hard at work shoving people around.

At first border tension in the U.S. appeared to me to be almost as deadly as the war in



Mexican migration
Early this century economic and political instability south of the border drove many Mexicans to the United States, but the Great Depression stopped that trend in its tracks. Later on Mexican laborers (above) could find jobs up north when they lost jobs to agricultural modernization at home.

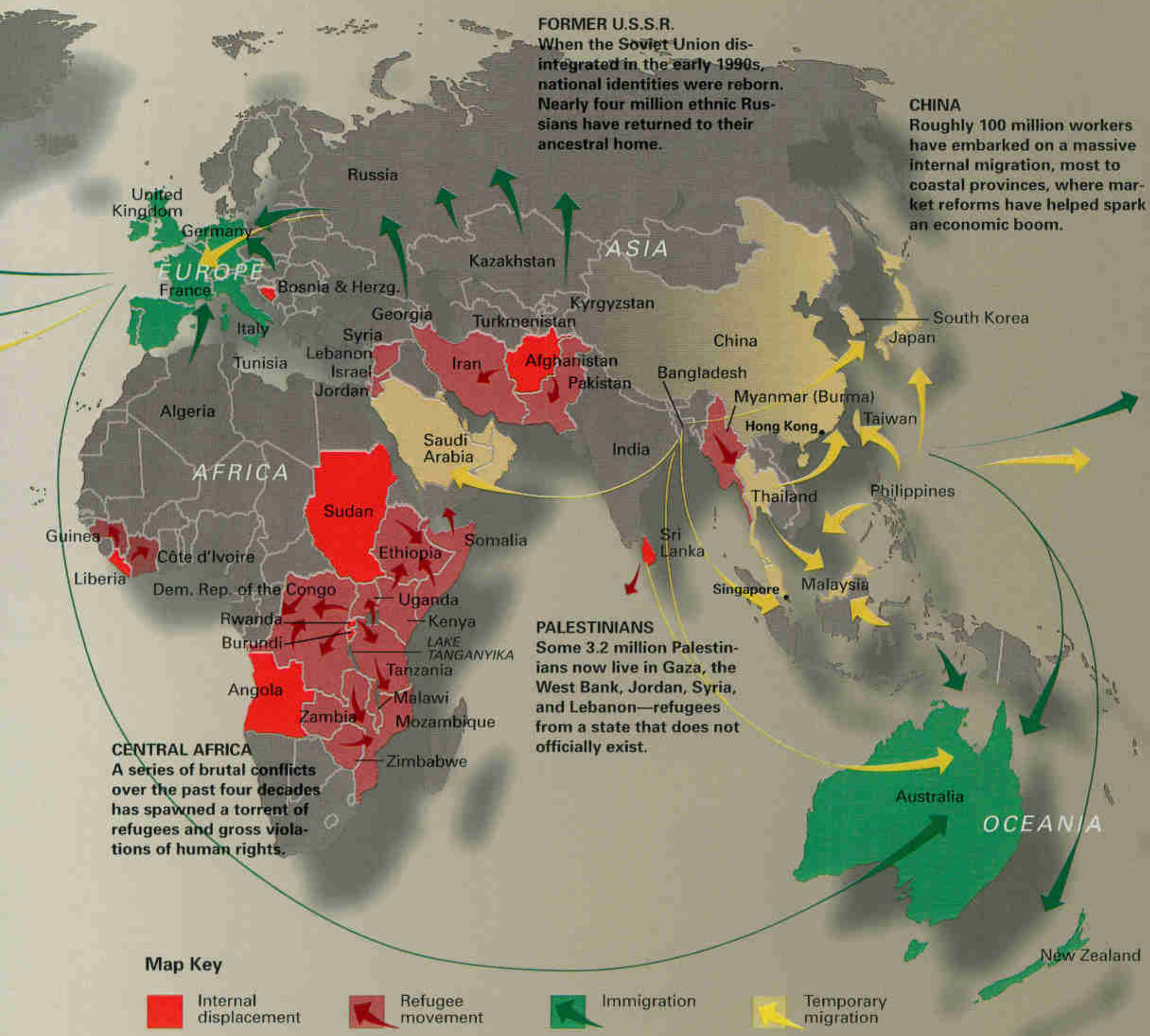




Legal immigrants to the U.S. (millions)

DATA: UN HIGH COMMISSIONER FOR REFUGEES; ORGANIZATION FOR ECONOMIC COOPERATION AND DEVELOPMENT; COMMISSION ON POPULATION AND DEVELOPMENT; INTERNATIONAL LABOR ORGANIZATION; SCALABRINI MIGRATION CENTER; U.S. IMMIGRATION AND NATURALIZATION SERVICE, DEMOGRAPHIC STATISTICS BRANCH

MAP AND GRAPHS BY DOUG STERN
PHOTOGRAPH BY KAREN KASMAUSKI



Making tracks: migration in the 1990s

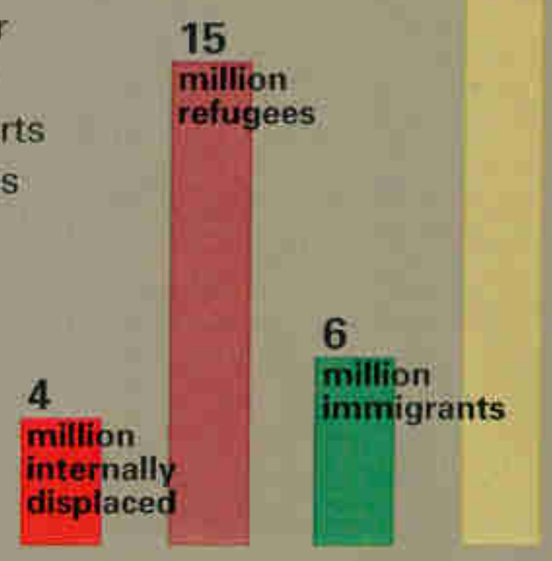
What drives migration? Demographers point to the interaction of two forces: the lure of a distant place—hope of a job, for instance—and the negatives of life at home, such as political unrest or a natural disaster.

While men and women in, say, the Philippines are often motivated by both impulses—the "push" of an anemic economy at home plus the "pull" of jobs in the Middle East—other migrants are uprooted involuntarily, often at gunpoint, and become refugees. Legally defined as a person who has "a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion," a refugee must reside outside his own country. Otherwise he is considered "internally displaced."

Native Americans and similarly uprooted indigenous groups are often missing from official statistics because the UN and other organizations use the post-World War II political map as a baseline. People displaced prior to that era are generally not tallied.

COUNTING HEADS

Estimates of the total number of "internally displaced" persons vary widely. Some experts believe this group might be as large as 50 million.





Carrying on an old tradition—American style—celebrants at the Feast of San Gennaro shoulder a statue of the saint in New York City's Little Italy. The procession passes by scores of streetside vendors hawking compact discs, T-shirts, sausages, "and anything else you



might imagine," says Father Fabian Grifone. "But as long as organized crime stays out of it, the mayor is happy—and I guess everybody else is." Eleven days long, this festival is worlds away from Naples, where the tradition began and where it remains a one-day religious event.

Shadows of the slave trade

Abandoned slave cabins on a Florida plantation belonged to Zephaniah Kingsley in the 1830s, but mounting racial tensions persuaded him to take his wife—who had once been his slave—and their sons and move to the Caribbean. Near Miami an animist tradition called Ayoba (below), with roots that run from West Africa through Cuba, attracts many African Americans on spiritual sojourns of their own.





Burundi: Human beings look wrong when you find them lying in an alfalfa field facedown. They have the wrong dimensions; they look too thick. It is chilling to see them lying so still.

Luis Diaz, a U.S. Border Patrol watch commander, and I had found the bodies with the help of another agent, named Peter, who had a big night-vision scope mounted in the back of a pickup. By two-way radio he had guided Diaz and me across the field. "More to the east. Now south." Suddenly there the bodies were, lying facedown, looking like packages of hay wrapped in colored cloth, so much more still than they ought to be in the chilly damp moonlight of a California February night.

"Make a line!" Diaz said to the bodies in Spanish. (Border agents here seem to call all illegals "bodies," as in, "There's two bodies moving toward area five.")

"Hands on your heads!" Diaz went on. "Over to the car!" The bodies, which had looked entirely dead, all got up, brushed off dirt and leaves, and started walking.

"How did you see us?" one of them asked in Spanish. Diaz didn't answer. "I'll let him figure it out," he told me later.

"Where're you going?" Diaz asked them.

"Al otro lado," one said.

"Sí," said Diaz, "but where on the other side?"

"Don't know," said one. "Los Angeles?"

"Is it beautiful, Los Angeles?" said another.

"Well," said Diaz, "it's big."

People from Central and South America call the United States El Norte, but to many Mexicans it is just over there, the other side. It sounds mystical. In a way, for Mexicans buried in poverty, it is.

"A better life," said Alejandro Bermúdez Pérez, when I asked him why he had tried to cross. He was in a holding tank at Luis Diaz's Calexico headquarters. There, at a desk surrounded by rooms that can hold a total of about 300 people, Alejandro was waiting to be fingerprinted and photographed by high-tech computer identification equipment.

He was a lean, quiet man of 24. He told me



about his wife and child, who lived at the edge of Mexico City. He had come to the border by bus and wanted to get work in the U.S.

"Now that you've been caught, what will you do?" I asked.

Alejandro stared at me with his solemn young face, and looked as if he was going to break out laughing. What did I think, asking that question?

But he maintained a straight face; he wasn't about to tell me in front of an agent that he'd be coming right back at him tomorrow.

"Maybe," he said innocently, "now I'll go back to Mexico City."

Alejandro's choice to go north is a perfect example of economic migration. This form of movement has lots of numbers behind it. The World Bank estimates that only 15 percent of the world's almost 6 billion people live in the 22 highest income countries, where the average income is more than $25,000 a year. Nearly all the rest, as well as most of the 80 million or so people added to the world each year, live in countries in which income is close to or less than the global average of $5,000 a year.

This would seem to create a straightforward flow from poor to rich. But it is not that simple. Some 120 million people in the world live in countries other than the one in which they were born, but more than half of these have moved to other developing nations, where the average income is little better than the countries they left. In addition, though you'd think that the poorest people would be the ones most prone to migrate, that's not so either. The image of throngs of abject poor clamoring on the borders of the wealthiest nations is wrong.

"The world's poorest people don't move, for the most part," Mark Miller said. Though driven by need, the people who do move are usually those who can come up with a few extra dollars for the trip.

It's easy to see how a rich nation like the U.S. could get the wrong impression of its immigrants: On the U.S. side of the border, people like Alejandro look like criminals, climbing





Keeping out of harm's way in central Africa

Bloody clashes in the heart of Africa have driven millions of people from their homes, including 332,000 refugees who in early 1998 resided in camps just inside the Tanzanian border. Near Kigoma, Jeanne Buchumi and her two children (above left) fled from fighting between Tutsis and Hutus in Burundi. At the Mtendeli camp some 31,000 refugees, many of them children (above), still await repatriation. The end of the civil war in the Democratic Republic of the Congo persuaded some evacuees to return home in March (left). One relief worker, asked to characterize the mind-set of a typical refugee, replied: "Stoic."

fences, slipping through the shadows, trying to evade the cops, hiding out in slums, ignorant of the language, dressed in clothes they've worn while lying in alfalfa fields.

But at home, they're heroes.

ONE SATURDAY IN MARCH I took a green Volkswagen taxi out of downtown Mexico City to an area northwest of town, where dense waves of small concrete-block homes wash up into the hills, the edge of that city's rising tide of humanity. There, in a small room painted a sunny yellow, in which a patched aquarium gurgled on top of a refrigerator, I talked with Alejandro's family.

"When you have a son," his wife, Lourdes, said, "you don't think of yourself. You have to make sacrifices. To tell the truth, he knew it was going to be difficult."

Around the table were Alejandro's mother, a brother-in-law, and his younger brother, César, who recently tried five times to cross to the other side and got caught each time. He's going to try again. "It's like a little worm inside," he said. "To go to the other side."

The family had heard from Alejandro. He'd called from California. After three or four attempts he had made it to the other side and was living with a few others who had crossed with him somewhere near San Diego. They didn't know how he was living, but I suspected it was in one of several infamously tough

On the move again, Congolese refugees grab their baggage before boarding a ferry to go home. Repatriation from Tanzania is a choice for these refugees, whose decision—to go or stay put—is influenced by radio broadcasts and the rumor mill.



shanty campgrounds in the hills near the city.

The family had planned the trip seriously. In Mexico, Alejandro had been making 600 pesos a month (about $70) as a car mechanic; from that and with loans from relatives they had saved the equivalent of almost a thousand dollars, some to pay for his bus fare and a fee to a *pollero*—a guide to get him across the border—and some to keep Lourdes going until the dollars Alejandro made started to flow south.

The long-term goal was to save enough money so they could open a small business, probably a car repair shop, in Mexico City.

"That is our dream," Lourdes said. "To tell the truth, if he were just working here that dream could not come true. Never."

Wondering whether their hopes for Alejandro were romantic or realistic, I asked them if they knew many people who had come back rich enough to do what Lourdes hoped.

"*Sí*, some people," said Alejandro's brother-in-law. "But we also know people who have come back with nothing."

Lourdes had her son on her lap, two-year-old Jesús Brandon Bermúdez Bautista. He was wide-eyed and curly headed.

Before Alejandro left, Lourdes had small photographs of the three of them put in key chains; one for her, one for him, "for the times when he needs to encourage himself to go on," she said.

"To tell the truth," Lourdes went on, "after he left I worried about Alejandro every day. When he got there, I cried. Then I rested a little from that fear that I had."

It was a pleasant morning, with warm air drifting through open doors and windows, a jacaranda tree blooming outside, voices of the children playing, and this competent and hopeful family talking about the loved one they'd launched into the distance. Watching them, I thought of Alejandro, living on the run in San Diego County, looking for any kind of work so he can send money home. Even when it's driven by economics instead of war, migration is still full of risks and hardship.

Alejandro's mother, María Elena Pérez Ramírez, was no stranger to the hard realities of movement. She had been part of it. A worldwide flow has been moving to cities for years and has probably affected more people than any other form of migration. She moved to Mexico City from the countryside of the state of Guanajuato about 20 years ago, because poverty was even worse where she came from.

"I started the migration," she said with a laugh. "It is a chain."



UNLIKE THE FLIGHT of refugees, which is usually chaotic, economic movement is a chain that links the world. Migration, a significant part of the trend toward a global system of communications and economics, continues to push us toward change.

In the Philippines the culture is a buoyant chaos of Asian and Spanish influence from previous centuries busy with migration. Now this country sends its people off to work almost everywhere.

When I was in the Manila offices of the Overseas Workers Welfare Administration

With their will, there's a way

Following in others' footsteps, North Africans have learned to sneak into Europe via Italy's Lampedusa Island (right), just 70 miles off the coast of Tunisia. Arriving here on fishing boats, they are ferried to Sicily, where they are ordered to go home, but most flee north and disappear. Italy is also a haven for Gypsies, many of whom live in semipermanent trailer camps on the outskirts of Rome (below).





(OWWA), I saw stacks of brochures to be given out to prospective migrant workers. The brochures were remarkably frank.

If you go to Singapore, one brochure said, "Good behavior means that: The maid . . . will not become pregnant." In Korea, another warned, "Employers are regarded as generally rude considering their strong voices and harsh ways. However, Filipinos . . . should not take this personally."

If you're going to Hong Kong, said another brochure, "OWWA advises the [worker] to . . . discard the 'Filipino time' mentality or face the consequences." For Saudi Arabia the advice was succinct: "If you think you are embarking for paradise, forget it."

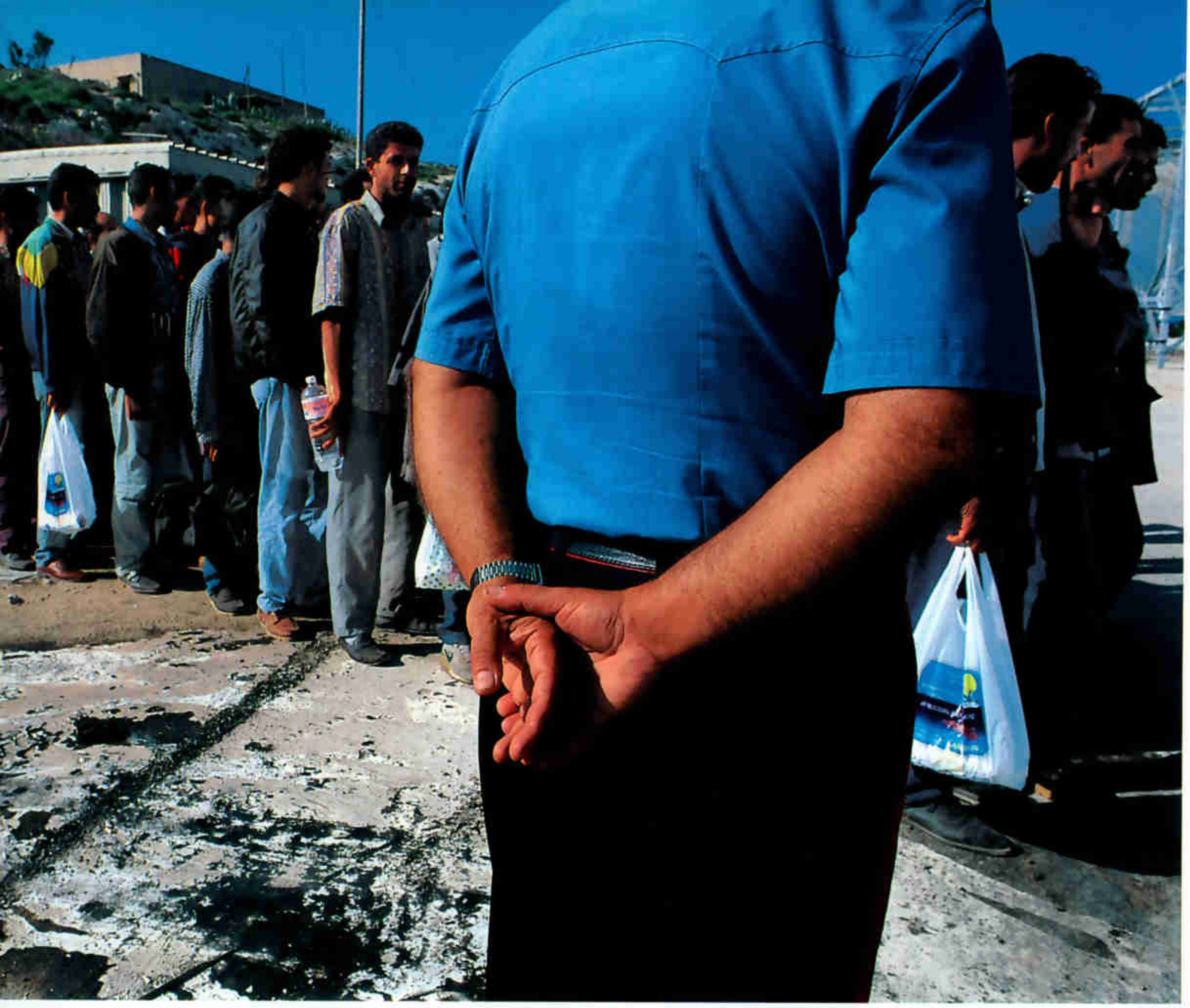
With a total population of 75.3 million people, the Philippines has 4.2 million working temporarily in more than 160 other countries, according to the OWWA. Of these, only 2.4 million are officially documented.

The Philippines experience demonstrates not only the global scope of migration; it also shows how far out on the edge of established society migrants can be. Countries that send migrants and those that receive them seem unable to deal with migration smoothly.

At home the Philippine government engages in complex and apparently contradictory practices. It does not officially encourage its people to work overseas, but it operates bureaucracies to help them go. Elaborate licensing systems, ostensibly for regulation, are actually designed to discourage riskier overseas employment, like maids or "entertainers"—who are often destined for what one Filipino official delicately called "the flesh trade."

The same kinds of contradictory rules prevail elsewhere. South Korea, for instance, calls its foreign workers trainees, though they may train at the same job for years at a time.

"A lot of countries are figuring out how to open the labor market [to outsiders] without appearing to do so," said Ricardo Casco, director of the marketing branch of the Philippine Overseas Employment Administration.



When I visited Ricardo's building, the place was full of people applying for work, taking orientation, even demonstrating dancing ability. Ricardo himself was an energetic, enthusiastic man who sounded like he would be at home on Wall Street, with talk of new paradigms, market behavior, and technology transfer.

"It's exciting," said Ricardo. "It's a historical, natural phenomenon to manage."

One of the most lucrative markets in this natural phenomenon is the trade in the services of young women.

THE SONG WAS "Goodbye Yellow Brick Road," by Elton John. In the long room 11 young women danced solemnly to the tune, turning and bending in unison while several of their friends watched from a doorway.

"If she is beautiful," said Eric Tiu, watching thoughtfully, "she makes $1,500 a month."

Tiu, a descendant of Chinese immigrants to the Philippines, is a recruiter of young female entertainers. He finds them on the island of Mindanao, 500 miles to the south of Manila. He brings them to the city, feeds and houses them for about four months, teaches them to dance, then sends them to Japan for three- or six-month tours, earning a fee from club owners for each one, as well as a hefty fee from the workers themselves. At the time I talked to him, he had about 700 entertainers in Japan and another 500 in training in Manila.

Tiu's staff, which includes some trained choreographers, teaches the women to dance because that's required by the government. Though everyone knows that these entertainers are hired to provide Japanese men with girls to flirt with, the government has decided to discourage the trade not with prohibitions but with regulations, and one of those is that each entertainer must pass a test of dancing *skills* she will hardly need.

Many of the dancers were cheerful. One was



MANILA GARDEN (5)
MAUREEN TAYO
LEYNI RUELO
MILDRED MERCADO
SEÑORITA (8)
SUSAN CABIAO
PENTHOUSE (15)
MARYANN POSADAS
V.I.P. (11)
NEW V.I.P. (15)

Flight from the Philippines

After their daily lessons—how to sing and dance, how to smile sweetly—women enrolled at a training facility in the Philippines (left) wait for a bus to their dormitory and for a chance to work overseas as "entertainers." Prior to departure, though, trainees must show they've got the right stuff (below). Training programs like this one, called Precise, provide the women with job contacts at clubs, most of them in Japan, and with help obtaining visas. Precise also promises to monitor their welfare and whereabouts (below left). Human rights advocates say such programs do little to prevent the abuses of the sex trade, but Philippine officials insist the programs are helpful: Young women will migrate anyway, they say, joining 4.2 million Filipinos already working overseas; these programs can provide protection.



Their roads led to Rome from the Philippines. Eric Zulueta came, via Chicago, with the U.S. Army. Michelle Salanguit, attended by Eric's cousin, migrated to Italy to join her mother. The couple now reside in Texas. "I'm American," says Eric, "but I'm part of another culture too."

Both were on board with their wives and kids.

"When we left," Patrick said, "there was a war. Children were running away along the shores of the lake. But the war is over now, though we don't know if our houses are still there. I was happy to leave for Tanzania, but I'm very happy to go back now."

"At least now," Jules said, "we'll be able to work and to study."

"What's the first thing you're going to do?" Suzanne asked.

"Get something to eat," Patrick said.

In the middle of the night the boat anchored just off the Congolese shore, still accompanied by the lamps of the fishermen. When the anchor dropped, a cheer rose into the darkness. After the cheer faded, someone on the ferry gave a single whistle. It was like a long birdcall, testing the night for friends. From one of the candles on the lake, a whistle came back.

Near the place the boat anchored to wait for the morning's disembarkation was a town named Baraka. I didn't know whether to take the word's meaning with irony or hope, but at least it reminded me of the way migration has woven its colors into every pattern of our lives. The word is Arabic, brought to the Congo long ago by traders. It means "blessing." □

Learn more about human migration at *www.nationalgeographic.com/features/2000/population/migration.*



Watching these women so far from home, I remembered what one recruiter (of domestics and factory workers) tells his clients to help them survive the first weeks on the job. "You will be so lonely," he says. "The only thing is to work yourself to sleep. And pray, pray, pray."

The money that entertainers and other working migrants send home is extraordinary. Young teachers in the Philippines make an average of $150 a month compared with entertainers' $500. The transfer of funds from migrants to their home countries, if lumped together, is one of the largest single movements of money in the world. In the Philippines it is an estimated eight billion dollars a year, almost three times the amount the Philippines receives in foreign aid. In all of Asia, money sent home by overseas workers totaled about 75 billion dollars in 1995, far more than the 54 billion dollars the same countries received in foreign aid.

None of the workers I met had signed papers saying they were going to return a single penny. Yet they did send home a vast amount of money, whole national defense budgets' worth of money, because of love.

MIGRATION TOUCHES raw places and deep places in many lives. One of those things, perhaps oddly, is the longing for home. This is one of the reasons immigrants so thoroughly enrich the cultures of the countries to which they move.

There's debate about what effect immigration has on the economies of the receiving countries. "Overall, society gains, but not everybody gains," says an economist at RAND, a Santa Monica, California, think tank. "People who directly compete with immigrants lose. The gains that do occur are smaller per person but affect a larger group of people." But there is no doubt that migrants' efforts to maintain a bit of home around them change the culture.

There are thousands of examples of this in the U.S. alone. One afternoon near Los Angeles I followed a group of Chinese lion dancers

Color matters but race doesn't seem to for the dance team at California's Walnut High School, where the student body has undergone a massive makeover. In 1986, 52 percent of the students were white, and only 16 percent were Asian. Today 23 percent are white, and 52 percent



are Asian. "It's been a smooth transition despite the language barrier," says principal Ken Gunn. But getting parents involved with the school remains a challenge. "In China," Gunn explains, "the educator has tremendous respect, and parents don't question the teacher."

around a community. The dance was a raucous celebration that Chinese store owners greeted with little envelopes of money. And on another weekend morning I floated on an inlet in Long Beach with two Chinese dragon boats whose crews of immigrants and the very American-sounding children of immigrants were practicing for races later in the year.

These attempts to make the new place feel as comfortable as home don't always work. While I watched the dragon boats, a harbor patrol officer came over to tell the skippers that people in a condominium on the shore had complained of the drumming that set the pace for the paddlers. Since there were clamorous outboards racing up and down the same inlet and no one had complained of that noise, the message was clear to me: Someone did not like to have their view crossed by people from China.

Perhaps in part because of their awareness of an unwelcome mat, vast numbers of migrants, including many of Mexico's illegal visitors to the U.S. like Alejandro, never expect to move permanently. Though some labor migrants eventually adopt the new country, most return home. And among forced migrants—like the refugees in Tanzania—home is the most magical dream in the world.



THE BIG BOAT moved almost silently across Lake Tanganyika. It was after midnight. Burundi lay in distant, dark folds of mountain to starboard, and the Democratic Republic of the Congo, previously Zaire, was near at hand to port.

The land was dark, but the waters were alight. All around us floated what looked like candles, as if to show this vessel, burdened as it was with fears and hopes, the long path home.

The lights were the fishing lamps of Congolese fishermen, who use the glow to draw fish up to their nets. The boat was a 180-foot ferry called the *Mwongozo*. The cargo was 800 refugees from the recent civil war in the Congo that had changed their country's name.

Like almost everything about migration, this journey was bittersweet and scary. Peace had been declared in the Congo, but it was fragile. The people on the boat, who had fled brutal attacks almost a year before, were not sure what they were going back to. Some of them told me their choice to sign up for this voluntary repatriation, sponsored by the UNHCR, was based simply on their hunger in the refugee camps, where rations had been temporarily cut in half because of washed-out roads and railroads.

"You might die in the Congo of a bullet," one refugee had told my wife, Suzanne, who speaks better French than I do. "But here your children will die of hunger."

Yet the jam-packed boat was cheerful. People stood in a crush of lines to get heaping plates of rice and beans cooked by a company called Happy Caterers. Up near the bow, where belongings were piled high in tarp-wrapped bundles, with a few handmade cages with chickens in them, Suzanne and I talked to a man named Jules, who had been a third-year medical student before the war chased him to Tanzania. With him was a friend, Patrick, who had been studying architecture.



Their roads led to Rome from the Philippines. Eric Zulueta came, via Chicago, with the U.S. Army. Michelle Salanguit, attended by Eric's cousin, migrated to Italy to join her mother. The couple now reside in Texas. "I'm American," says Eric, "but I'm part of another culture too."

Both were on board with their wives and kids.

"When we left," Patrick said, "there was a war. Children were running away along the shores of the lake. But the war is over now, though we don't know if our houses are still there. I was happy to leave for Tanzania, but I'm very happy to go back now."

"At least now," Jules said, "we'll be able to work and to study."

"What's the first thing you're going to do?" Suzanne asked.

"Get something to eat," Patrick said.

In the middle of the night the boat anchored just off the Congolese shore, still accompanied by the lamps of the fishermen. When the anchor dropped, a cheer rose into the darkness. After the cheer faded, someone on the ferry gave a single whistle. It was like a long birdcall, testing the night for friends. From one of the candles on the lake, a whistle came back.

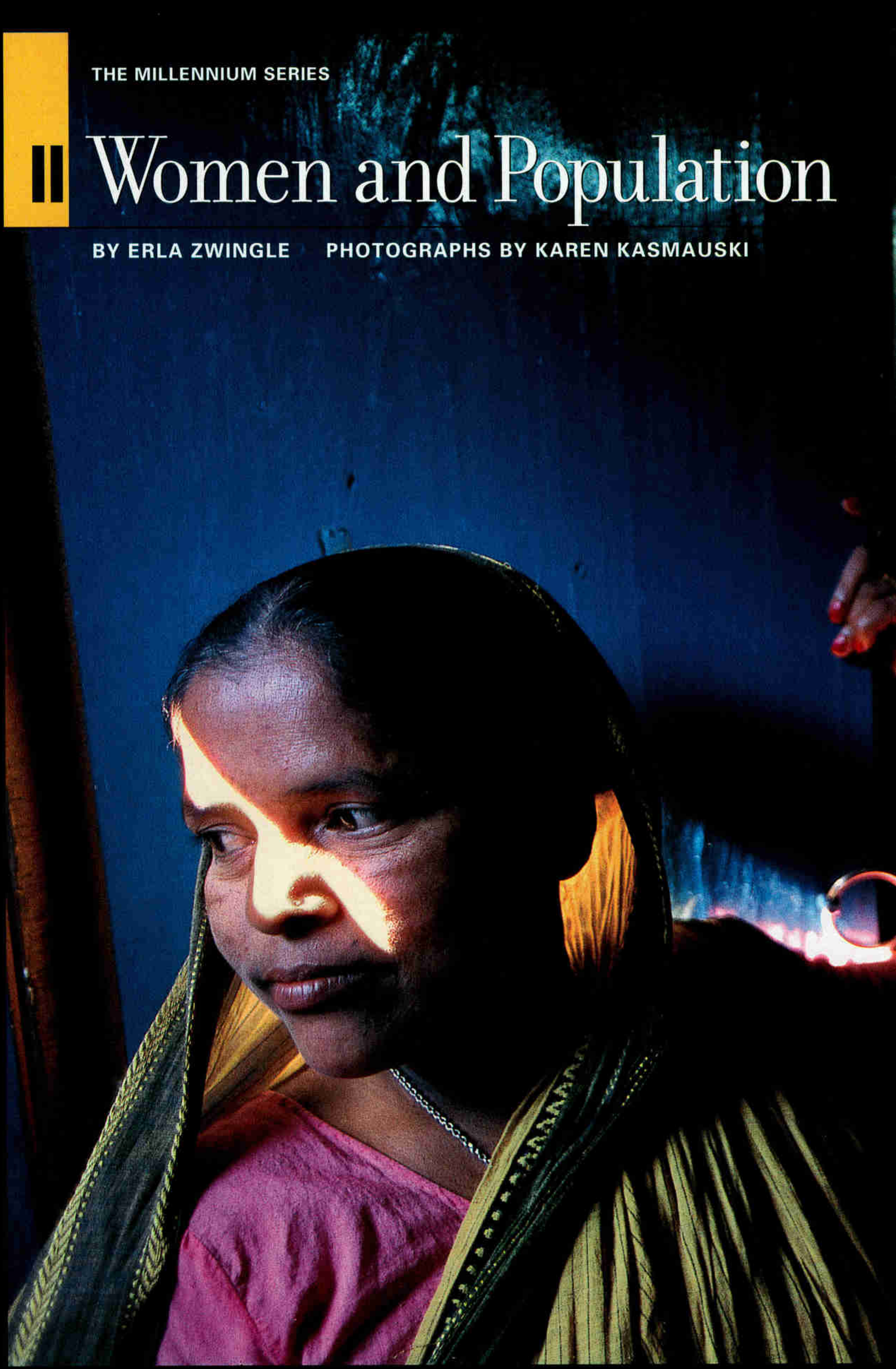
Near the place the boat anchored to wait for the morning's disembarkation was a town named Baraka. I didn't know whether to take the word's meaning with irony or hope, but at least it reminded me of the way migration has woven its colors into every pattern of our lives. The word is Arabic, brought to the Congo long ago by traders. It means "blessing." □

Learn more about human migration at *www.nationalgeographic.com/features/2000/population/migration.*

THE MILLENNIUM SERIES

Women and Population

BY ERLA ZWINGLE PHOTOGRAPHS BY KAREN KASMAUSKI





■ Architect of her own happiness, a Bangladeshi widow stands in the house she built for her family with money from a bank for the poor. Worldwide, new opportunities are allowing women to choose smaller families and richer lives.

"Don't look at people like an ant heap,"

ON A CERTAIN NOVEMBER DAY an obscure woman in Iowa gives birth to seven babies; we marvel and rejoice. On the same day an obscure woman in Nigeria gives birth to her seventh child in a row; we are distressed and appalled.

In Brazil a mayor sees his town shrink by two-thirds. Determined not to lose subsidies tied to population, he bans all contraceptives. In Bangladesh the government, determined to stem the tide of births, offers to sterilize women for free and throws in a new sari as a gift.

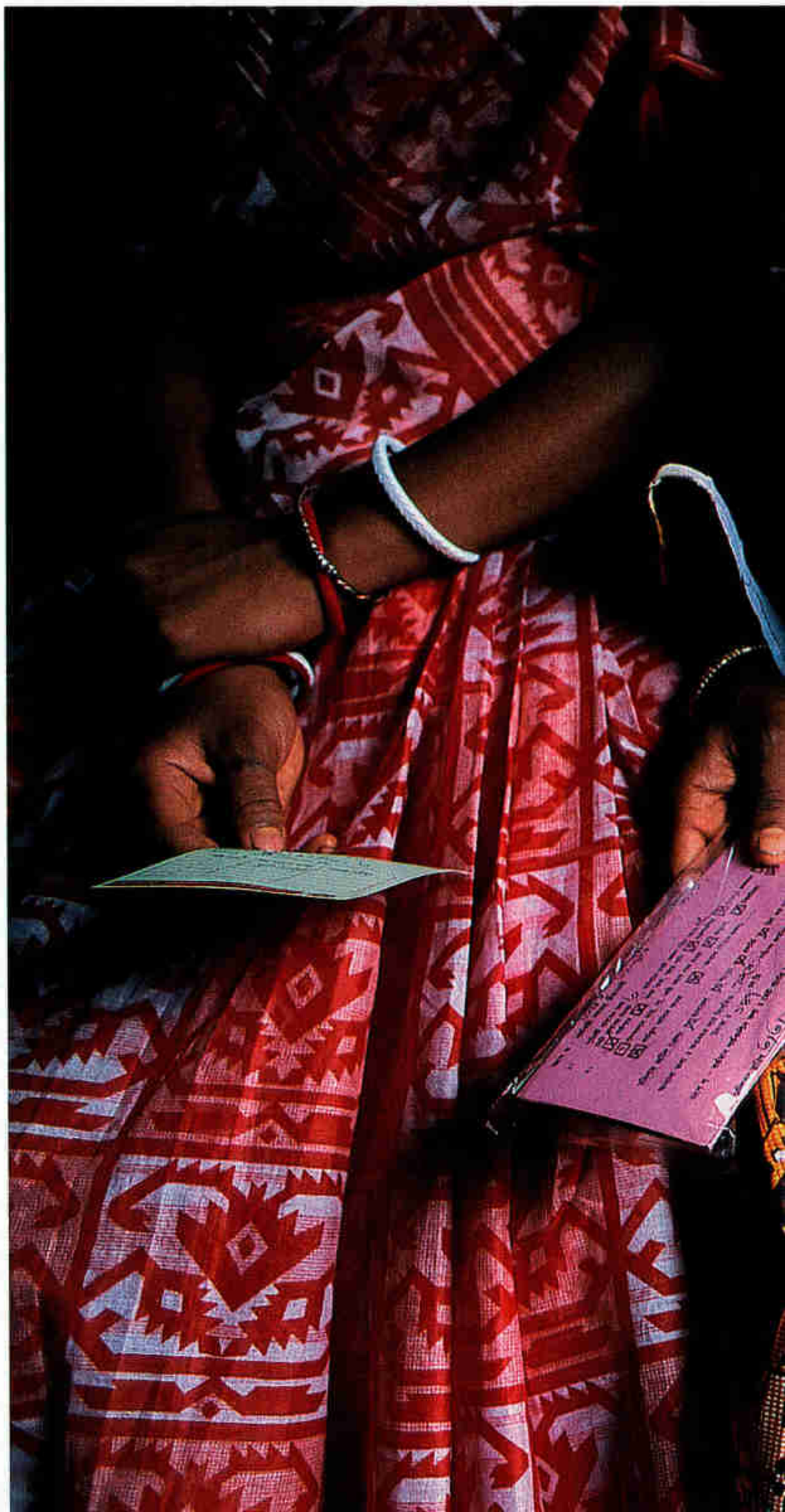
In Kenya a woman keeps trying for a son because her husband asks, "Who will hold my head for me when I die?" In the United States an unmarried teenager looks at her infant daughter and says, "I don't really know what I was doing. I thought I was in love. I thought it was this great thing, but it was stupid."

Population: We know it's a problem. In fact most of the problems facing individuals, families, communities, and nations are affected by the quantity of humans sharing the planet. But if the problem were only numbers, these stories would have no power to touch or perplex us. Nor would we race to bring food to famine-stricken countries, or blanch to read of newborn babies being thrown into trash bins, or fall silent upon hearing of the pregnant mother who refused cancer treatments that could damage her baby, gave birth, and died. Even as some fear for our species' survival, we instinctively sense mysteries that transcend statistics. "Don't look at people like an ant heap," one expert urged. "These are individuals."

Two hundred years ago Thomas Malthus predicted mass catastrophe as a result of overpopulation. So far, events have not turned out quite as he supposed they would, yet the brutal probabilities he described continue to darken some views of the future. Today 98 percent of population growth is in the developing world. "The world is going to hell," as one observer bluntly paraphrased the common fear, "if those people don't stop breeding."

True, the numbers give pause. Today there are almost six billion people in the world. For the next 15 years annual increases will probably remain just over 80 million (or one billion every 12 to 13 years). The United Nations estimates that by the year 2050 there could be from 7.7 billion to 11.2 billion people in the world.

Will this be too many? It is difficult to predict, as even Malthus would have seen by now. Predictions often impel changes in the very behavior that inspired the prediction. Providing enough food, of course, is paramount. But what about fresh water? Forty percent of the world population faces water shortages at



Freelance writer ERLA ZWINGLE lives in Venice, Italy, a country in which the falling birthrate is a serious concern. Photographer KAREN KASMAUSKI, a mother of two children and a veteran of 16 GEOGRAPHIC assignments, also focused on human migration for this issue.

one expert urged. "These are individuals."

some time during the year. What about jobs? There is already an increasing shortage of those too, and according to the Population Reference Bureau masses of unemployed people form "a social and political time bomb."

But there has been dramatic progress over the past 30 years. Birthrates have dropped in many developing countries (including China and India), and the number of children born to each woman has fallen on average from six to three. This is the result of remarkable changes on three fronts: contraception, health care, and culture, the strongbox in which our sense of what we can do is locked.

Contraception has been the key. The number of women in some developing countries using contraceptives has risen to more than 50 percent. "There isn't any place where women have had the choice that they haven't chosen to have fewer children," says Beverly Winikoff at the Population Council in New York City. "Governments don't need to resort to force."

Yet some 200 million women become pregnant each year. Half of these pregnancies are

Soon to have a sibling, an only child nestles in her mother's sari at a clinic in Bangladesh. Nurses provide checkups and offer advice—starting with "space your children." Longer gaps between births mean healthier mothers and babies and slower population growth.





unplanned, and a quarter are unwanted. Unwanted children are often neglected, abused, or abandoned. They receive less food, medical care, and education than wanted children.

More than half a million women die each year from causes related to pregnancy, often the result of poor health, lack of medical care, and having babies too close together. Seven million infants die each year because their mothers were not physiologically ready for pregnancy or lacked obstetric care. Millions of women and men resign themselves to this reality. But with the chance to plan their families, they are beginning to see a way to re-imagine their future. "People are desperate," one woman said, "to control their own destiny."

IN BANGLADESH dawn rises over banana groves and palm trees, the emerald expanse of rice fields, and pools where women in vivid saris immerse themselves, drenched in the golden light. Here the problem of overwhelming numbers seems obvious. Bangladesh is the ninth most populous nation on Earth, and, with only 52,000 square miles of land, it is one of the densest. It is also one of the poorest.

Today Bangladesh is praised as a population success story. In 1990 its birthrate was an unbridled 4.9 children per woman (which, if unchanged, would have doubled its population by the year 2015). The rate is now 3.3, a fact that has astonished those who believed the country's population would drop only after chronic poverty and illiteracy were overcome.

Much of the credit goes to two of the many organizations that help the poor: the Dhaka-based Grameen Bank, with its innovative program of "microcredit," or small loans, and the Bangladesh Rural Advancement Committee (BRAC), with its nationwide network of village clinics. The work of BRAC and Grameen has made it possible for millions of women and children who once could hope only for survival to begin to dream of progress. Mosammat Anowara Begum is one of them.



Woman to woman

Pledged to bear no more children, a volunteer with the Bangladesh Rural Advancement Committee counsels a pregnant woman in Shoal village (left) and dispenses antibiotics for a mother's sick baby (below). She also discusses family planning. Contraceptives distributed by such workers helped lower Bangladesh's birthrate from seven children per woman in 1975 to fewer than four in 1995.



Chamurkhan village isn't very different from the 68,000 other villages in Bangladesh: an assortment of one- or two-room houses with corrugated metal roofs and walls of palm matting, clustered around small common areas of beaten earth. As the morning light begins to spread through the trees, a rooster crows; a baby gives a small, fretful cry; a dog barks. Someone nearby hawks and spits. Then the phone rings.

Anowara Begum has the only phone in the village; it's a Nokia cellular phone. She bought it with a loan from the Grameen Bank, and she makes money with it. Instead of selling milk or eggs, as many of her neighbors do, she sells telephone calls at 4.6 taka (about ten cents) a minute. At this rate, she can pay the phone bill and weekly loan installment and keep some profit too.

"Every week I make 300 taka [$6.50] from the phone," she says, "and I repay 160 taka. In three years the loan will be repaid." In some parts of Bangladesh an illiterate widow with several children could be destined to beg or even turn to prostitution. But once the loan is paid off, Anowara Begum stands to net an average of $2 a day—more than $700 a year—in a country with an average annual per capita income of about $250.

Since its launching in 1976, the Grameen program has loaned more than two billion dollars, in amounts averaging only $180, to more than 2.1 million destitute women.

"We find that when women start borrowing, it benefits the whole family," Mohammed Abul Hossain, a senior officer at Grameen, tells me. "Her children become important, the family's welfare becomes important." One recent study in Brazil showed that income controlled by the mother had a benefit on her children's health that was almost 20 times greater than income controlled by the father.

Sharifa Akhtar Shikha, Anowara's 20-year-old daughter, studies Islamic history at Dhaka's Jagannath University. "If my mother hadn't gotten the loan," Shikha says, "it would have

been impossible for me to go to the university. But she wanted me to have a higher education."

Why? Anowara smiles. "For the future," she answers. "She will be independent and have more income. And she'll be happy also."

When people can start making decisions about their lives, they also start making decisions about the size of their families and vice versa; family planning within Grameen families is twice as common as the national average. Surveys have also found a strong link between education and family planning.

But Bangladesh still has a high death rate of babies and mothers. Here females die earlier than males (the opposite of the biological norm), due in part to severe malnutrition and risky pregnancies, often too close together.

To help improve health care, BRAC has founded clinics throughout the country. "Many more women want contraceptives now," said Mergina Khatun, a village health worker in Mymensingh district. "They see that if a mother has fewer children, she can give them better care. And her health will be better."

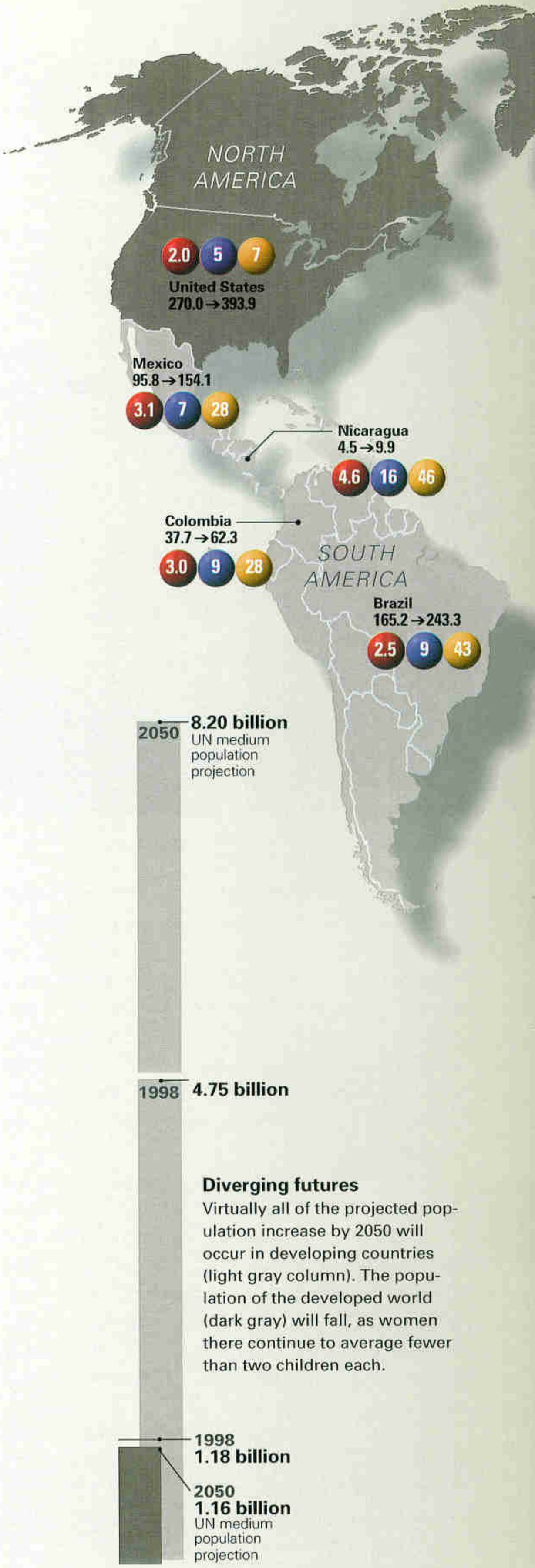
What if a conservative Muslim leader tells Mergina that contraception is against the will of God? "I say that God also told us to be responsible for our families."

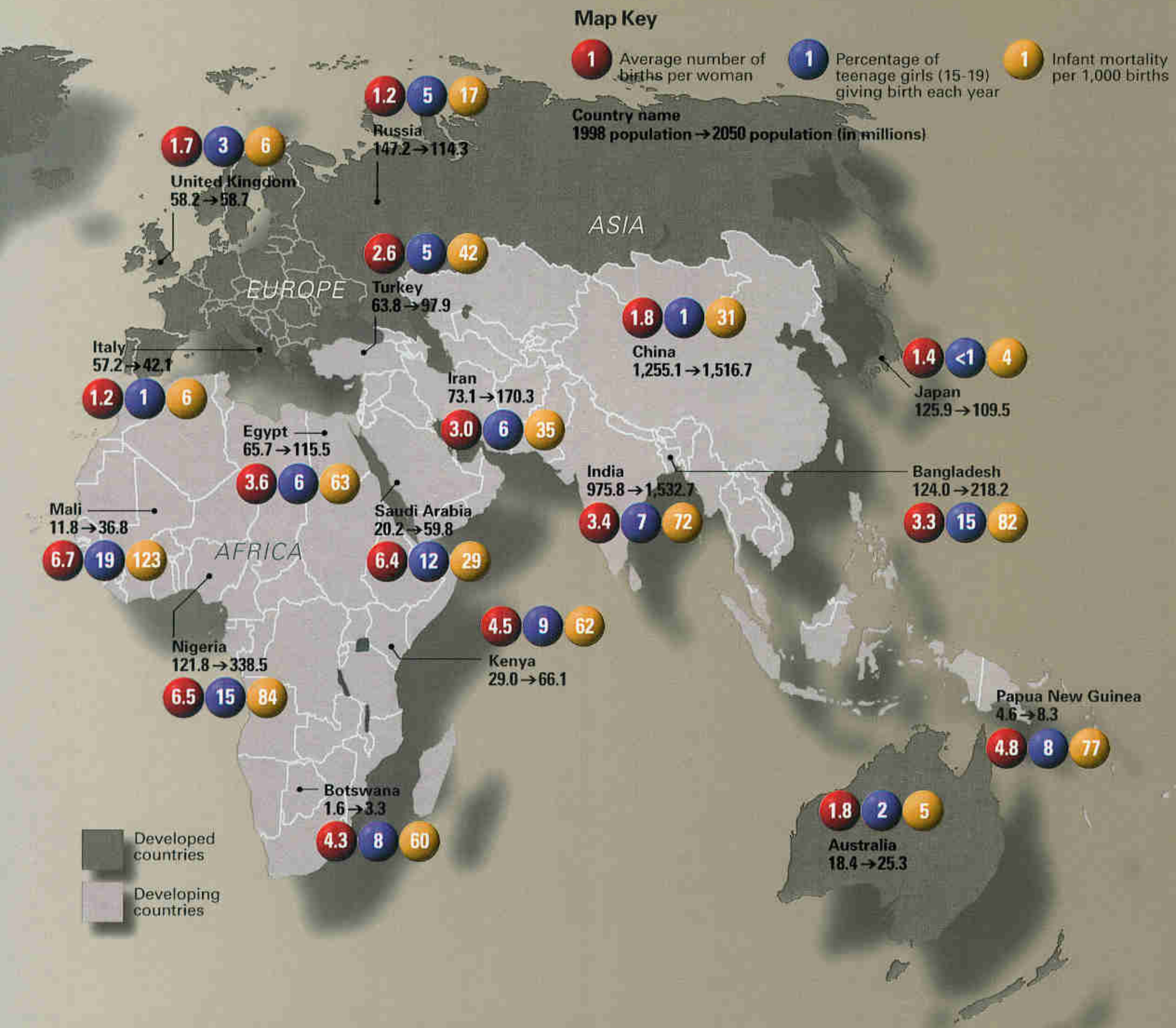
In the BRAC health center in the town of Mymensingh, the nurse is counseling a few of the 800 women who visit every month. A thin young woman, three months pregnant, sits listlessly by the desk. She tells the nurse that she has been suffering from morning sickness and has an intermittent fever. She is 20 years old and has been married three and a half years. This is her third pregnancy; she has already suffered one stillbirth and one miscarriage. Contraceptives could have helped her delay these pregnancies until her health improved.

The nurse advises her to take full bed rest, eat extra food, and do no heavy work. None of this will be possible for her. The nurse prescribes an antihistamine spray and an analgesic for the pain and fever. The girl's gray-haired mother-in-law crouches on the floor, leaning against the wall, waiting silently.

Loans and contraceptives continue to improve the lives of Bangladeshi women and their children. But sadness still inflects the lives of even healthy families.

"I have three daughters; the youngest is just a year and three months old," says Firoza in





Health, wealth, and population

In what experts call a "virtuous cycle," family planning leads to healthier women, since mothers avoid early, late, or closely spaced births. Healthier women have healthier children. And fewer child deaths lead to fewer births, as women stop believing that they must have many babies for a few to survive. In the past many concluded that economic development was the best contraceptive. Now, backed by studies showing family planning is the most effective means of lowering births worldwide, experts say, "Contraceptives are the best contraceptive." Yet development and its benefits, especially better education and health care, remain essential. Such advances raise demand for family planning, persuade young couples in poor countries to postpone childbearing, and encourage the treatment of women as men's equals. According to the nonprofit Population Council in New York City, "One can promote a smaller world by promoting a more just world."

Wealthier and healthier
In developed countries (dark gray columns) fewer births and teen pregnancies coupled with better health care mean that fewer mothers and babies die.



BASE MAP AND POPULATION DATA: UNITED NATIONS POPULATION DIVISION; UNITED STATES CENSUS BUREAU. HEALTH ISSUES DATA: POPULATION REFERENCE BUREAU

MAP AND GRAPHS BY STEPHEN ROUNTREE

Army of entrepreneurs

Saluting the future, women meeting near Dhaka to repay loans acknowledge the loan officer from Grameen Bank, who freed them from lives of powerlessness and isolation. "We shall plan to keep our families small. We shall keep free from the curse of dowry. We shall not practice child marriage"—so runs the creed Grameen clients, who are 95 percent female and 100 percent poor, recite as a promise to break from traditions of poverty. Launched into business with a small loan, a woman travels from door to door selling cookware (below). Anowara Begum (below right) used a loan of $390 to buy a cellular phone, which fellow villagers pay to use. Soon after the death of her husband, Anowara hears from her brother in Malaysia while their mother weeps. For birthrates to keep falling, experts say women must be offered opportunities beyond motherhood and given the authority to choose whether to bear children.











Taldighi village. "My husband is disappointed. Now he is saying he didn't want any more children. Two would have been better, he says, since the third one was a girl."

"I had twin baby boys," her neighbor, Alefjan, tells me. "They died of a respiratory infection, one when he was seven days old and the other when he was 14 days old. My husband told me, 'We don't need to go to the hospital—they don't have drugs for children this small.' And I believed him."

"WOMEN AND POPULATION," repeated Beverly Winikoff at the Population Council when I told her my topic. "It sounds like you're treating women as the disease vector." What about men?

The sun rises over Nairobi, gilding the dusty parks, the battered streets, the chaotic, makeshift markets. Kenya used to have one of the highest birthrates in the world, but in the past 20 years it has shown one of the steepest declines in all Africa. As in Bangladesh this is due in large part to massive education campaigns, more clinics, and inexpensive contraceptives. But Africa, which still has the highest birthrates in the world, remains profoundly child centered. "A person who doesn't have children is looked down on," a woman explained, "because that person is incomplete in the society."

In much of the world men have often been the major objectors to family planning. Some do so on the basis of religious beliefs; others want to demonstrate their virility. Many believe that only the fear of becoming pregnant will keep their wives faithful. And there are misunderstandings: "I used to hate family planning," a man told me, "because I thought it meant that people shouldn't have children."

Yet as men struggle to provide for their families, some admit that smaller families are better. To help them become more involved in family planning, male-only clinics have begun to appear in Kenya, Ghana, and some South American countries. And a few pioneers, overcoming the common fear that sterilization will



Early parenthood

Seven months a mother, Jill Crisler, 16, fixes a bottle for her son, Trenton, before leaving for Northeast High in Lincoln, Nebraska. Like many teenage births, this one was unplanned. "It's not a mistake," says Jill. "I call it a surprise." Unlike most unwed fathers, Luke Smith stays in his son's life, hurrying from his job to his new role as Trenton's playmate at the school day care (below).



make them impotent, are choosing vasectomy.

Philip Njuguna is pastor of the Nairobi Calvary Temple, a Pentecostal church in a poor neighborhood. At 37 he is a small, compact man with a friendly, intelligent expression. I first meet him in the male-only suite of the Marie Stopes Clinic downtown.

The main waiting room is full of women and children watching television and reading magazines. The rooms next door are for men only. The yellowish walls bear a few modest posters: "Plan your family now—your children's future depends on you." "45 million men around the world have had a vasectomy."

"My father had just eight acres," Philip tells me. "It was an average-size farm but not enough for 13 children. In the morning there was just a cup of tea. No lunch. Poverty eats you every day.

"What made me decide to have a vasectomy was that I wanted to have a family I could raise," he continues. "My wife was taking pills, and she had high blood pressure. Who am I to my wife? I'm her partner. I'm there to help her. That's what the Bible says. So I read about vasectomy. The only side effect is that you can't have children anymore"—he smiles—"and that's the side effect I wanted."

To their credit many men worry about the possible side effects some contraceptive methods may have on their wives. Then again, studies show that men are generally reluctant to use methods that directly involve them—withdrawal, abstinence, condoms, and the rhythm method. As for vasectomy, says clinic counselor Patrick Musyoka in his gentle voice, "The stigma is still there."

Men are the point at which family planning leaves the realm of mechanics and enters the mysterious territory of behavior. Contraceptives themselves are simple—it's the users that are complicated, caught up in the volatile dynamics of human relationships. "Family planning came to Kenya through health programs for women," Godwin Mzenge, a program director, tells me. "The assumption was that women would discuss with their husbands



Premature parents, mothers at Lincoln High School gather at lunch as part of a student-child program that helps them graduate. The U.S. has the highest teenage birthrate in the industrialized world. Adolescent births endanger mothers and their babies while accelerating population



growth. Rather than stressing either abstinence or contraceptives alone, successful prevention programs also emphasize setting and achieving goals. "Hope is the most important method of birth control," says Susan Powers-Alexander, of Lincoln's Planned Parenthood.



what they learned. But now we know that communication between them isn't that common."

"We encourage the women to keep discussing," says Rose Ngahu, a nurse. "It takes a lot of force of character to resist the husband."

IN LINCOLN, NEBRASKA, a crisp autumn morning spreads across the prairie, over the flags snapping in front of the state capitol, over the football fields ready for marching-band practice after school. In the half-light students are arriving for class at Lincoln High School. They carry the usual teenage stuff: books, musical instruments, backpacks. Some of the girls are also carrying their babies.

The U.S. has the highest teenage birthrate of any industrialized nation. Since 1960 the rate has tripled among unmarried females age 15 to 19. According to the Alan Guttmacher Institute, four in ten American girls become pregnant at least once before they reach 20; most of these pregnancies are unintended.

We think of Lincoln as the real America. And it is, but not always in the way we mean. "I'd like to have a baby," said Tonya, a pert 12th grader, "but not now. Too many of my friends have babies: Mindy, Janet, Penny, Becky, Sue Ann, April. . . ."

This is bad news, for a number of reasons. First, there is sheer quantity: By the year 2000 there will be more adolescent girls in the world than there have ever been: 400 million poised to begin having children. If they were to delay their first baby by five years, it would mean 1.2 billion fewer people by the year 2100.

Second, there is the quality of those lives. Of the nearly four million babies born each year in the U.S., nearly one out of eight is born to a teenage mother. When a girl under 20 has a baby, problems mount for everyone. She may well drop out of school, in which case she is likely to go on welfare. (In 1995 the government spent 37 billion dollars on welfare, food stamps, and Medicaid for families begun by a teenage mother.) Emotional immaturity can lead her to abuse her baby; it can be hard to



Smaller is better

Dressed in school uniforms their mothers struggled to buy, Masai children drink a breakfast of tea in the doorway of a house in rural Kenya. In Nairobi, Philip Njuguna, a pastor, watches his third child and only son (below). Njuguna underwent a vasectomy after the boy was born. "When the family is small, whatever little they have they are able to share," he says. "There is peace."



overcome the stresses of pregnancy and labor on a body that hasn't finished developing. "It's a myth that because they're younger, they're healthier," one woman told me. "What teen do you know who eats right?"

Her baby also may very well have difficulty: Infants born to teenage mothers are at higher risk of low birth weight, prematurity, and stillbirth than children born to women age 20 to 24. They also tend to have lower test scores and higher rates of physical and psychological problems. Sons of teenage mothers are more likely to serve time in prison. The state of Utah found that every $400 spent on a teenage mother saved the state $400,000 in various social costs over the lifetime of her child. But many of the girls only know that they are overwhelmed. "I didn't feel shame," one of them said. "I felt fear."

In 1993 some of the staff at Lincoln High opened a child-care and learning center at the school. They—and their colleagues at Northeast High—avow that their first priority is to make sure the girls graduate. "We *want* the girls to be successful," says Karen Poore, a teacher at Northeast. "Whatever will help them complete their education, we advocate."

There was resistance. "Some people didn't want Lincoln High to be known as 'the pregnant school,' " says Ann Irvine at the public school district office. "There was still the shame factor. We had to get over that." And objections came from those who were convinced that a day-care center would be seen as encouragement to be promiscuous. "The girls just laugh," says JoAnn Bartek, who teaches family and consumer sciences. "They say, 'Oh yeah, that's really what we were thinking: They've got this really neat day-care center; I think I'll go get pregnant.' "

As for those who maintain that the girls shouldn't be in school, according to Bartek, the girls say, "Well, where should we be? If we don't get our high school diplomas, we're going to be on welfare. We're going to be homeless." One study found that almost 60 percent of

Masai children gather for opening ceremonies at Kimuka Primary School in Kenya's Rift Valley. Adapting to a shrinking supply of cattle land, Masai herders are bearing fewer children in hopes of sending all their sons and daughters to school. Africa has the world's highest



birthrates, but they are starting to fall with better health care and education, stronger family-planning programs, and—in countries such as Kenya—weak economies that make it hard to provide for many children. Even so, the continent's human numbers will double in 30 years.

teens who became pregnant dropped out of high school. At Northeast and Lincoln High 80 percent of pregnant teens are graduating.

I meet some of these teens at the child-care center at Lincoln High. The room is spacious and cheerful, full of toys and cots and intensely clean. Several girls are here on their lunch break, crouched on the floor playing with their babies or talking with the assistants and each other. A few sit quietly, nursing. The mothers look more like older sisters.

At 3 p.m. Mandy Brehm comes to pick up her eight-month-old daughter, Juliana. Mandy is 16; she has long brown hair, green eyes, and a pretty, round face. She's named in *Who's Who Among American High School Students.* When we get home, her mother, Diane, and her younger brother, Jared, are there.

There is pizza for dinner. As we eat, Diane recalls the day she learned her daughter was pregnant. Mandy couldn't find the courage to tell her; instead she left a note on her mother's bed. "It said, 'I'll never be the daughter you wanted. This is the worst day of my life. But I don't want to kill the baby.' I cried for about two hours. Then I called her at school and asked if she wanted to come home."

Many girls do not have the support or the determination that Mandy did. Fifty percent of abortions in the U.S. are sought by women younger than 25.

"My own thought," says Beverly Winikoff at the Population Council, "is that most people wouldn't use abortion as a first choice. But they're pregnant, and they need not be."

What will Mandy tell Juliana when she grows up? "Not to have sex," she replies. " 'Cause it's not worth it."

Mandy will probably be the only person telling her that. "We bombard kids with sexual messages, but we don't teach them how to process them," says Susan Powers-Alexander, a director at Planned Parenthood in Lincoln. "We don't teach kids to decipher that they're using sex to sell cars, perfume, pineapple."

The influences on adolescents are powerful and pervasive: movies, advertising, music, peer pressure. The girls face life with a wild assortment of mismatched traits: ignorance, bravado, curiosity, delusions of invulnerability. The reasons for teen pregnancy go on. Many teen mothers are children of teen mothers. Alcohol and drugs undermine the ability to make clear decisions. Older boys can dazzle or dominate: Over half the males responsible for teen births are 20 or older. Early sexual abuse cripples the capacity to say no; one study reported that 48 percent of high school students who had been pregnant were once sexually abused. And there is fear of losing love.

"Part of the reason I was so reckless was I didn't like myself at all," Mindy Latzel, 18, tells me. "He was 22 at the time. He made me feel good about myself, telling me how pretty I was. But I guess it was a bunch of lies."

"HOW MANY CHILDREN should we have? How far apart?" Stan Bernstein, senior research adviser at the UN Population Fund, asks rhetorically. "How should we educate them—concentrate on a few and hope they'll take care of us?" These



Married but without children, a Masai teenage bride looks forward to her first pregnancy. While many women's lives are still dictated by circumstance, more and more now enjoy choices. In their hopes, fed by new possibilities, the future is born.

discussions are happening more and more.

The World Health Organization estimates that sexual intercourse occurs a hundred million times a day. Yet despite the great strides of the past three decades, millions of couples who want to use contraception don't have access to it. Many developing countries, faced with economic crisis and political uncertainty, are shrinking their financing of family-planning programs. Some foreign donors have also cut back on aid—the U.S. by one-third.

In Kenya a man says, "When my wife didn't want to have more than three children, my mother told her, 'You're just lazy.' "

In Bangladesh a woman says, "Two children are enough. Because if you have more, you can't raise them as human beings."

In the U.S. a 16-year-old father looks at his infant son and says, "I'd probably be locked up in some juvenile hall if he wasn't here. He's changed me for the better."

The sun rises every morning on more than a quarter of a million newborn babies. A few of them may change the world; all of them will change their mothers and fathers. They don't belong to the ant heap. They belong, for better or for worse, to us all. □

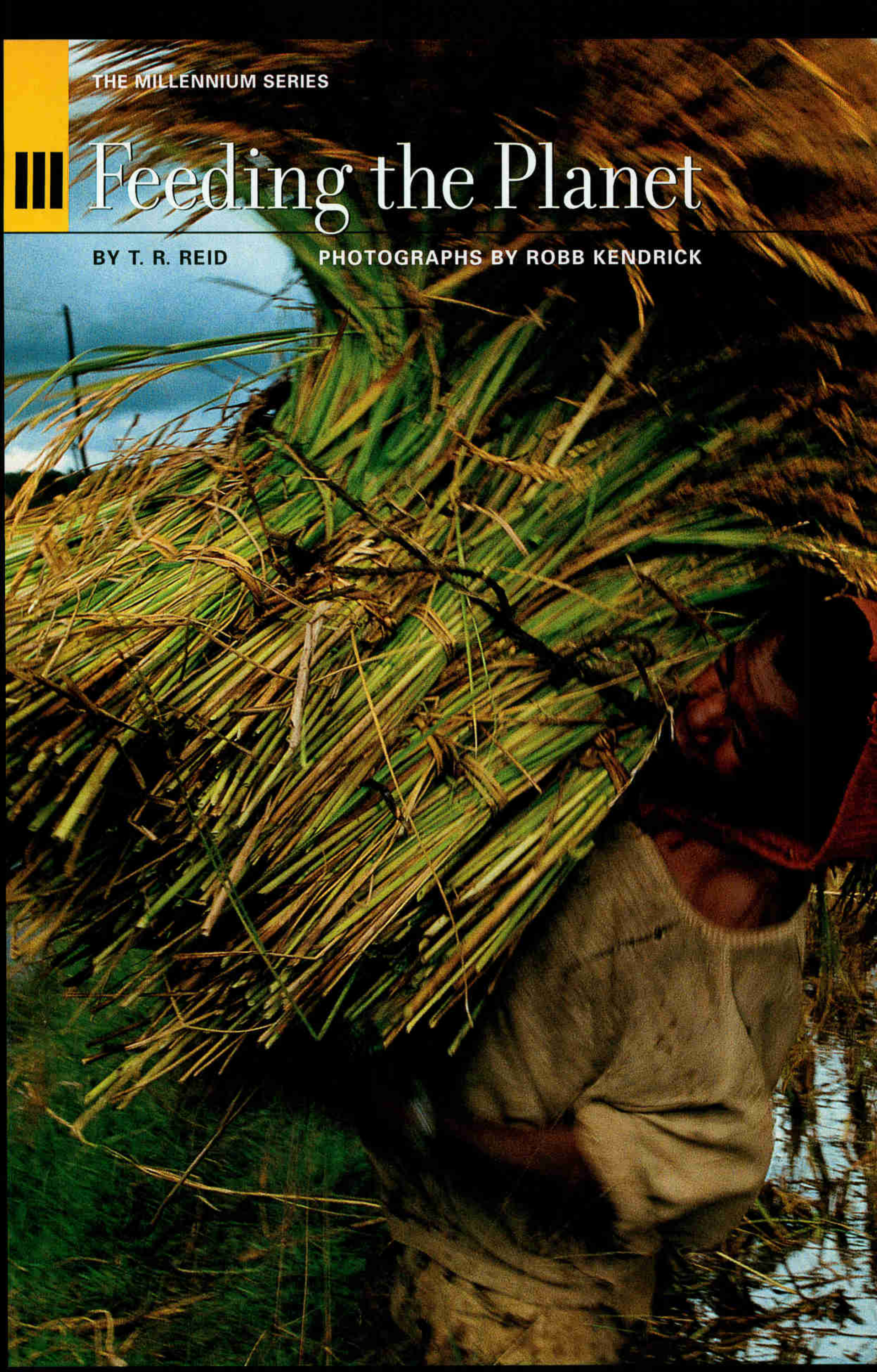
Erla Zwingle reports further on teenagers and pregnancy at *www.nationalgeographic.com/features/2000/population/women.*

THE MILLENNIUM SERIES

Feeding the Planet

BY T. R. REID

PHOTOGRAPHS BY ROBB KENDRICK



■ **Bringing in the sheaves is backbreaking work in Madagascar, which imports rice to supplement its own harvests. As the global population—now at 5.9 billion—continues to grow, providing for all will take monumental effort.**

ROBB KENDRICK, AURORA & QUANTA PRODUCTIONS

Can the planet produce enough food to feed

ON THE DAY YOU READ this, the population of our planet will increase by 230,000 people. *Hungry* people.

In 1998 about 137 million human beings will be born, and some 53 million of us will die. That amounts to a net population gain of 84 million—more than 230,000 additional residents of the Earth every day of the year. Many of these newcomers will suckle their meals from a mother's breast for a year or so, but after that it will be up to Mother Earth to provide them food and drink. Our fragile, overextended planet and its hard-working human population will have to feed those 230,000 hungry people day after day for the next 66 years—not to mention another quarter million tomorrow, and the next day, and the day after that.

These sobering numbers raise two crucial questions: Can the planet produce enough food to feed the 5.9 billion human beings alive today and the billions more who will be born over the next few decades? And if we do manage to produce enough, do we have the wit and the will to distribute the Earth's bounty to all those who need it?

Earlier this year—just as the farmers where I live were heading out to their fields for spring planting—I traveled around the world looking for answers to these questions. I came away feeling reasonably optimistic on the first point: Up to now, at least, human production on the farm has done a superb job of keeping up with human consumption at the table. The issue of distribution, though, is more problematic.

People have been debating the planet's carrying capacity at least since Socrates' day. Many experts, at many different points in history, have predicted that the world would soon be overpopulated, leading to famine and suffering on a gargantuan scale. So far, these predictions of disaster have all turned out to be wrong.

Exactly 200 years ago, when the world's population was nearing one billion, the British economist Thomas Malthus offered the most famous statement of the basic dilemma. Population, he said, must increase, because "the passion between the sexes is necessary and will remain." But food supplies could not possibly increase as quickly: "The power of population is infinitely greater than the power in the earth to produce subsistence for man."

Modern-day Malthusians have been, if anything, even bleaker. A quarter of a century ago Paul Ehrlich, a leader of the global environmental movement, warned that our world was on the verge of "famines of unbelievable



T. R. REID currently serves as a London correspondent for the *Washington Post* and National Public Radio. This is ROBB KENDRICK's third assignment on food issues. He photographed our May 1994 rice story and our November 1995 article on ocean fisheries.

the billions who will be born in the future?

proportions." The population was about 3.5 billion, which Ehrlich believed was the limit. Feeding six billion people, he wrote in 1976, "is totally impossible in practice."

Next year the world's population will reach six billion—and human beings overall are better fed than ever before. Thirty years ago, according to the United Nations, the global food supply represented 2,360 calories per person per day. By the mid-1990s total food supply had increased to 2,740 calories per person per day. Supply will continue to grow faster than population at least through 2010, the UN predicts.

The big jump in population in the second half of this century has created much greater demand for food. But supply has increased even faster than demand, and the price of staple foods has fallen dramatically. Over the past 40 years the price of wheat, in constant dollars, has declined by 61 percent; the price of corn has dropped 58 percent.

A hot meal means little more than bread for migrant workers in India. Though farms worldwide produce enough to feed everyone, hundreds of millions cannot afford a balanced diet. With greater numbers competing for food in the future, rising prices may leave many more hungry.



Improvement plan rained out

Freak rains flooded the usually parched land near Marsabit, Kenya, last year, stunting a drought-resistant strain of corn donated by Food for the Hungry, a U.S.-based aid organization. Like many in the developing world, farmers here have little money to buy such seed varieties —or most other components of the green revolution. Ready to try again, they struggle to plow a soggy field the old-fashioned way.





THE ABILITY TO PRODUCE more and more food each year stems from one of history's most important inventions: the farm.

For the first hundred millennia or so of our species' existence, a person's next meal depended on which nuts shook loose from trees or which wild animals could be clubbed. But somewhere around 8000 B.C. Neolithic man—actually, some scholars say, it was probably Neolithic woman—began farming. Women figured out that if they saved some of the grain they gathered, scattered it on the ground and waited around a few months, more grain would spring up.

The first significant agricultural crops were grasses: barley, wheat, rice, etc. These grains quickly became the staff of life—so valuable that almost every early religion known had a specific god who could be invoked to guarantee the grain harvest. In Western civilization the most important grain deity was the Roman goddess Ceres, which explains why the Wheaties, Corn Flakes, and Rice Krispies we eat in the morning are known as "cereal." The ancients were obviously onto something, because even today more than 70 percent of all cultivated land is devoted to cereal grains. These crops provide the bulk of human nutrition; most of the calories we consume come from grain or from eating animals raised on feed grains.

Traders and travelers transplanted local crops around the world, and these green emigrants often flourished in their new homes, a fact obvious to anyone who has traveled through the central plains of North America and seen there oceans of waving wheat, a plant native to the valleys of the Tigris and Euphrates Rivers in what is now Iran, Iraq, Turkey, and Lebanon.

The agricultural revolution was accompanied by another fundamental change in the pattern of life: The birthrate came to exceed the death rate, and world population began a steady growth. Of necessity, agriculture



became the dominant human endeavor—and still employs nearly 50 percent of the world's labor force.

To produce more food, humans expanded the amount of land under cultivation and found ways to increase the yield from existing fields. For the most part this has been a success story. But each breakthrough has had undesirable by-products.

Around 3000 B.C. the invention of the plow greatly increased the output from a given plot of land. But plowing left soil vulnerable to erosion, prompting the agriculture historian Daniel Hillel to observe that "the plowshare has been far more destructive than the sword." The industrial revolution enabled a single farmer to cultivate more land—with proportionate increases in energy consumption and air pollution. In the 1960s the new plant varieties and agrochemicals of the green revolution yielded huge increases per acre, but many fertilizers and pesticides left toxic residues behind. Despite innovations—and sometimes because of them—soil and water degradation threaten agricultural output worldwide.

Still, improvements in agriculture have kept food supplies high enough to meet the growing world demand. What Malthus called "the power of population" has been matched and exceeded by the power of innovation. Global food production today is sufficient to provide everyone on Earth an adequate diet.

And yet hundreds of millions of people do not get the 2,200 calories per day generally accepted as the nutritional bottom line. About 20 percent of the developing world's population is chronically undernourished; 30 years ago the percentage was twice that high, so we're making progress. But why must anyone go hungry?

The problem is not production but distribution. Local food supply often has little to do with natural conditions. Some of the best-fed people live in countries—Japan, for example—that don't have enough land to grow their own food. Some people who live in green meadows washed by regular rainfall are hungry. A major

A fleet of hired combines on Walter Mehmke's Montana farm cuts wheat destined mainly for Pacific Rim nations. The use of such machinery along with high-yield plants and agrochemicals has more than doubled global grain production in the past few decades and has turned the

U.S. into one of the world's major food exporters. "When I was in high school, if we cut 30 bushels an acre, that was an excellent crop," says 50-year-old Mehmke. "Here we're cutting about 80." Whether technology can continue to boost yields so dramatically remains to be seen.

reason for the disparity between haves and have-nots is politics. Most of the world's governments have the political will to assure their people the basic elements of a reliable food supply. But some don't.

IN THE GLOBAL HIERARCHY of agricultural wealth, the ultimate haves are the broad, fertile, high-tech nations of North America, where a tiny portion of the population—about 3 percent in Canada, and even less in the United States—grows more food than their countrymen could ever eat.

Not long ago I traveled across the High Plains of eastern Colorado to visit a fairly typical American farm, owned by Bob and Joanna Sakata and their son R. T. Like many family farms, this one has a tale behind it: Bob grew up farming in California in the 1930s. In the wake of Pearl Harbor, for no reason except their race, Bob's family was shipped to an internment camp in the Utah desert. There Bob heard that Japanese-American farmers were still welcome in Colorado. In 1945 his whole family settled near Brighton and began to cultivate a 40-acre truck farm.

Five decades later the operation is known as Sakata Farms and covers some 3,500 acres along the South Platte River. Bob still calls his business a "small family farm," but its output is awesome: 20 million pounds of onions per year, 15 million pounds of cabbage, and 25 million pounds of corn. If you are reading this in the U.S. in early autumn, the fresh corn you saw in the supermarket this morning may well be Sakata Gourmet Extra Sweet.

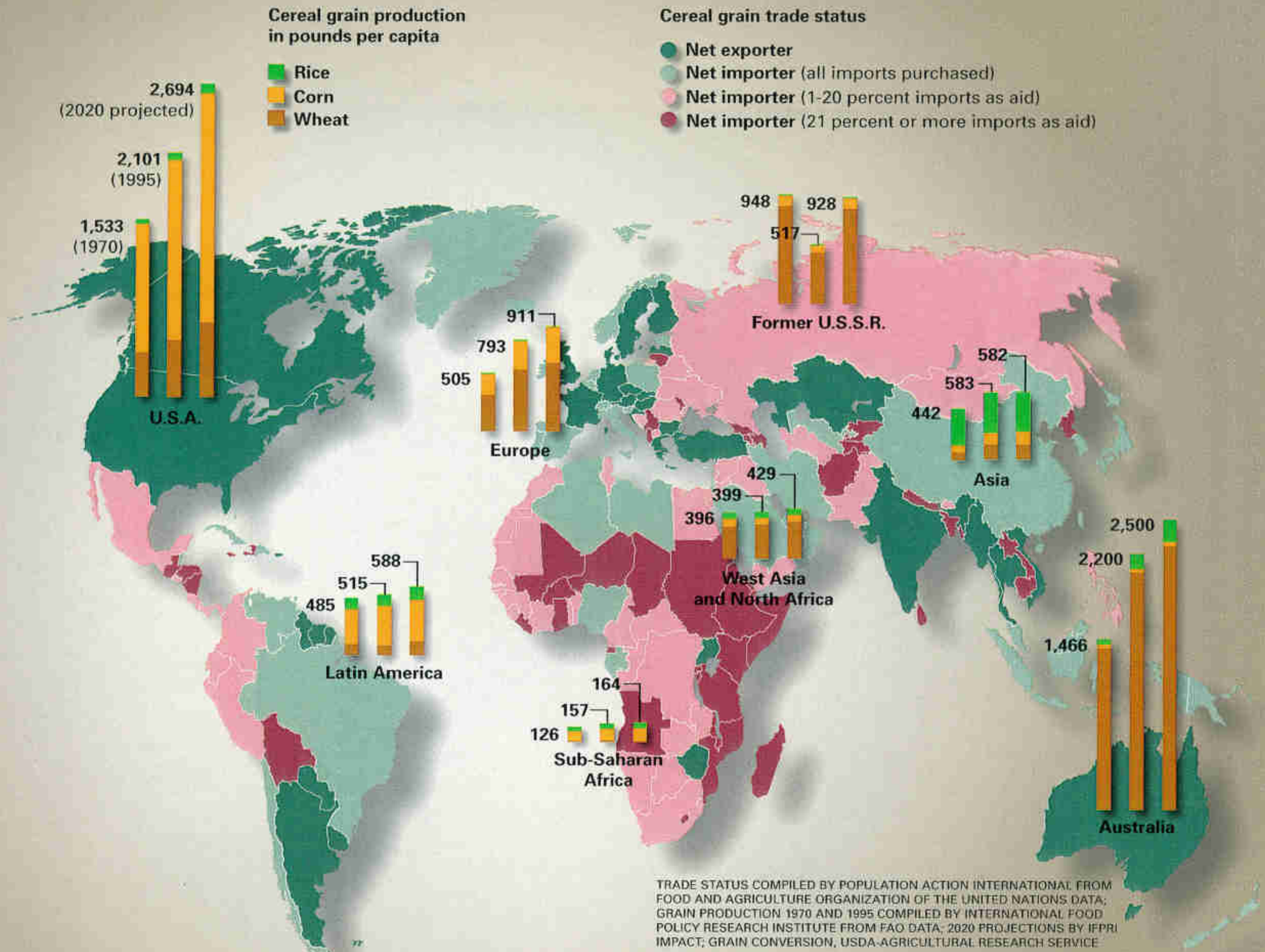
"The only way you can stay in business as a farmer," Bob told me, "is to boost yield and reduce your costs. Fifty years ago, when we started here, an acre planted in onions would produce about 200 sacks"—that is, 50-pound sacks of yellow onions. "When we got that up to 350 sacks per acre, we thought we were the hottest thing in farming. Today, if we don't produce 800 sacks per acre, we can't compete with the guy down the road."

Increases like that come partly from research into new plant breeds, new fertilizers, and new growing techniques, and partly from massive investment in high-tech equipment. Bob's son, R. T., who got a college degree in biochemistry before returning to Brighton to grow vegetables, gave me a tour of the maintenance building. The place looked more like a *Star Wars* hangar than a farmer's machinery shed.

The pride of Sakata Farms' big fleet is a matched pair of Pixall Super Jack corn pullers. These enormous yellow machines move slowly but surely through a field of corn, grabbing each stalk and plucking off the ears so gently that barely a kernel is bruised in the process. The Super Jacks cost the Sakatas $160,000 apiece in 1995, and maintenance costs are astronomical: When one of the harvesters had a flat last summer, R. T. had to shell out $905 for a new tube and tire. But these behemoths



Keeping body and soul together, 70-year-old Charles Smith visits New York's Bowery Mission for a meal and a chapel service. Some 30 million people—mostly elderly, children, and the working poor—go hungry in the U.S. despite its wealth. "Many ask, 'Do I pay the rent or buy food?' Or in the winter, 'Do I heat or eat?'" says Christine Vladimiroff, head of Second Harvest, a relief organization that distributes more than a billion pounds of food a year.



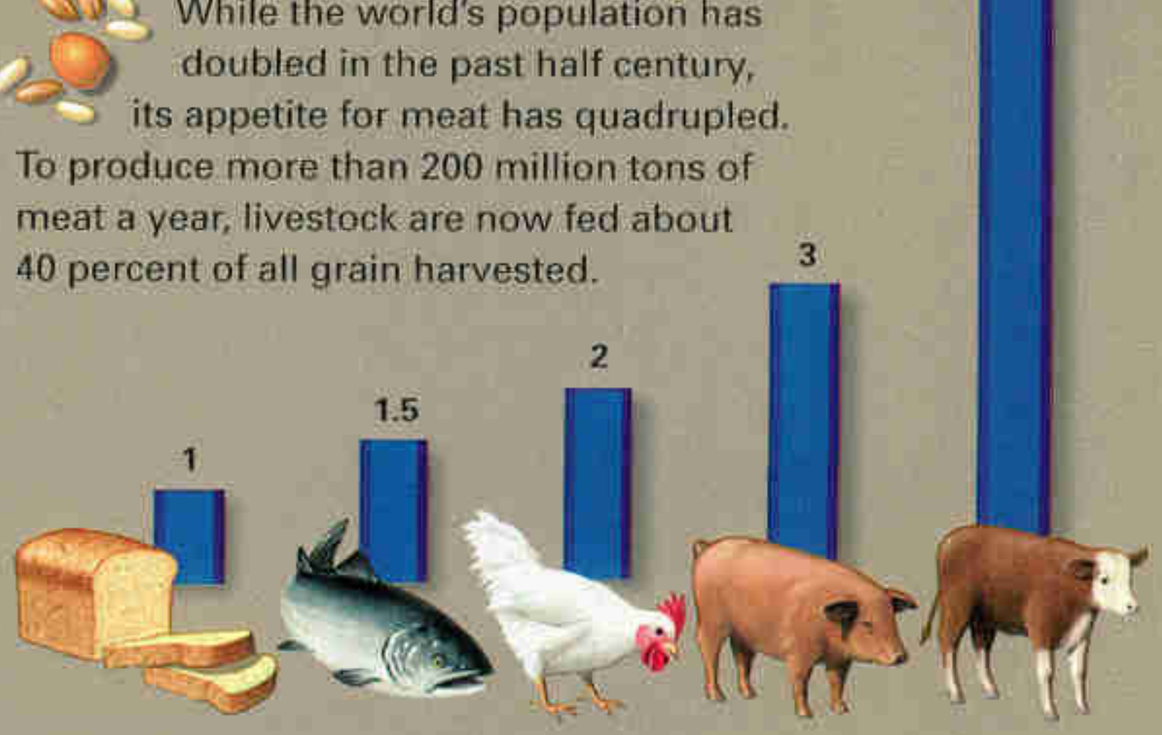
Golden harvests from the good earth

"More than 99 percent of our food comes from the land," says David Pimentel, an agricultural scientist at Cornell University. "That's a fact that a lot of people don't appreciate." Among the many crops cultivated, grains provide at least 80 percent of food worldwide. Farmers and consumers alike benefit from grains' advantages. Yields per acre are normally abundant. Also, grains store and transport well—unlike potatoes, for instance, which are swollen with water—and they contain a nutritious mix of carbohydrates, proteins, and vitamins.

Just three crops—wheat, rice, and corn—dominate grain production. This specialization has helped drive the agricultural boom of the past 30 years, as investments in equipment and supplies targeted to one kind of plant over many acres paid off with bumper crops. Relying so heavily on such a narrow genetic base is risky, however. One virulent disease could cause crop failure and famine.

Even if crops stay healthy and cereal grain production continues to climb as projected above, the global food supply may ultimately fall short. With growing populations of their own, regions that now enjoy a surplus will likely have less and less for export to those in need.

While the world's population has doubled in the past half century, its appetite for meat has quadrupled. To produce more than 200 million tons of meat a year, livestock are now fed about 40 percent of all grain harvested.



Pounds of grain needed to produce one pound of bread or one pound of live weight gain in each animal.



pay their way. At the height of harvest season, each one picks and bundles 240,000 ears of sweet corn every day.

I was overwhelmed by the size, power, and complexity of those corn pullers. Tilting back the dark green Sun Seeds cap on his head, R. T. did his best to calm me down. "Yeah, these machines seem pretty impressive today," he said. "But in a few years, just to stay competitive, we'll probably have to find something that harvests even more. That's why, from our point of view, it's hard to think that the world's ever going to run out of food. Somebody's always finding ways to produce more and flooding the market. And the rest of us have to match it, and it just keeps going."

THE CORN the Sakatas produce in such abundance is a native American plant species, but it has also flourished, as a transplant, in most of central Africa. In fact, white-kerneled corn, known as maize, has become a staple food of sub-Saharan Africa. People roast it right on the cob, grind it into meal, or serve it as a side dish similar to grits that is called *ugali* in Kenya and Tanzania, *posho* in Uganda, and *sadza* in Zimbabwe. Even the churchyard of Holy Family Cathedral in central Nairobi has been used to plant a cornfield.

"The growing conditions here are unsurpassed anywhere," said Monty Crisp, an American development worker I met in Rwanda. "In the central U.S. farm belt we have some rich soil but only one growing season per year. Here there is great volcanic soil and the potential for two or three crops per year." Yet the UN Food and Agriculture Organization notes that sub-Saharan Africa is worse off nutritionally today than it was 30 years ago, and hunger and malnutrition remain rampant.

One reason is that the majority of African farmers cannot afford to buy improved seed varieties, agrochemicals, or machinery. Their tools: a machete to clear weeds and, sometimes, a single hoe for an entire farm family.



Competing pressures

A new highway near Hong Kong has the right-of-way where a farmer now squeezes in a patch of bok choy. In the past decade development has overrun much of China's arable land. Meanwhile demand has risen for crops—to feed more people and to fatten more livestock for the tables of the newly affluent. In Guangzhou, a city of 6.5 million, the Tianhe slaughterhouse is expected to double its output of pork.



I saw this kind of agriculture in the hills of northern Kenya. A retired Wisconsin farmer named John Hooper—a volunteer for the Scottsdale, Arizona-based aid organization Food for the Hungry International—took me to visit a 4.5-acre farm, a large operation by local standards. As is common in Africa, the farmer was a woman: Ellen Kuraki, a strong, quiet mother of eight. Ellen's husband works as a pastor, so the farm is her responsibility.

Kuraki has vegetable plots, a mango grove, and a chicken house set high on a post to thwart marauding mongooses. But most of her farm is planted in maize. When the weather is reliable, she produces enough to feed the entire Kuraki family, with a little left over to sell. The farm generates about $225 a year.

The biggest obstacle to earning more, Ellen told me, is time. She gets two crops of maize each year. Each harvest takes about two weeks to cut the stalks and pull the ears, and then another week or so to clear the field for the next planting. It is all hand labor. Hearing that, I began thinking about what she might do with a miniature version of the Sakatas' huge corn-puller. The same thought occurred to John Hooper. "You know, with one of those small combines they sell now," he said, "she could clear this whole field, shell every ear, and it would take, oh, half an hour or so."

When Ellen overheard us talking about farm machines, her eyes grew wide. "If I had a tractor," she said, "we could grow so much!" And then her smile faded. "But we have no money, we have no fuel, we have no parts to keep a tractor running. It's just not possible."

In other parts of the world governments help provide the seeds, tools, and soil conservation farmers require. But they begin by supplying political stability. Amid the nearly endless civil strife that has beset equatorial Africa, farmers' needs have gone largely unmet.

"We have always been farmers, but how can we farm now?" said an intense, angry man named Bulondo Musemakweli, whom I visited in the village of Nzulu, on the bank of ink-blue



A pipeline muscles snakelike through a suburb of Mumbai, formerly Bombay, in India to supply richer areas with plenty of water. Buying into a neighborhood with such amenities is beyond the means of residents here. With no running water in their homes, they share public spigots



in alleyways. Even with international efforts to make access easier, more than a billion people around the world still don't have a reliable source of water that is safe to drink. With the global population swelling by about 80 million a year, the situation is unlikely to improve soon.

Lake Kivu. Bulondo, a short, muscular father of 12, is the headman of Nzulu, near the eastern border of the Democratic Republic of the Congo. The village is home to 500 people who have been swept into a state of hunger and poverty by distant political manipulations.

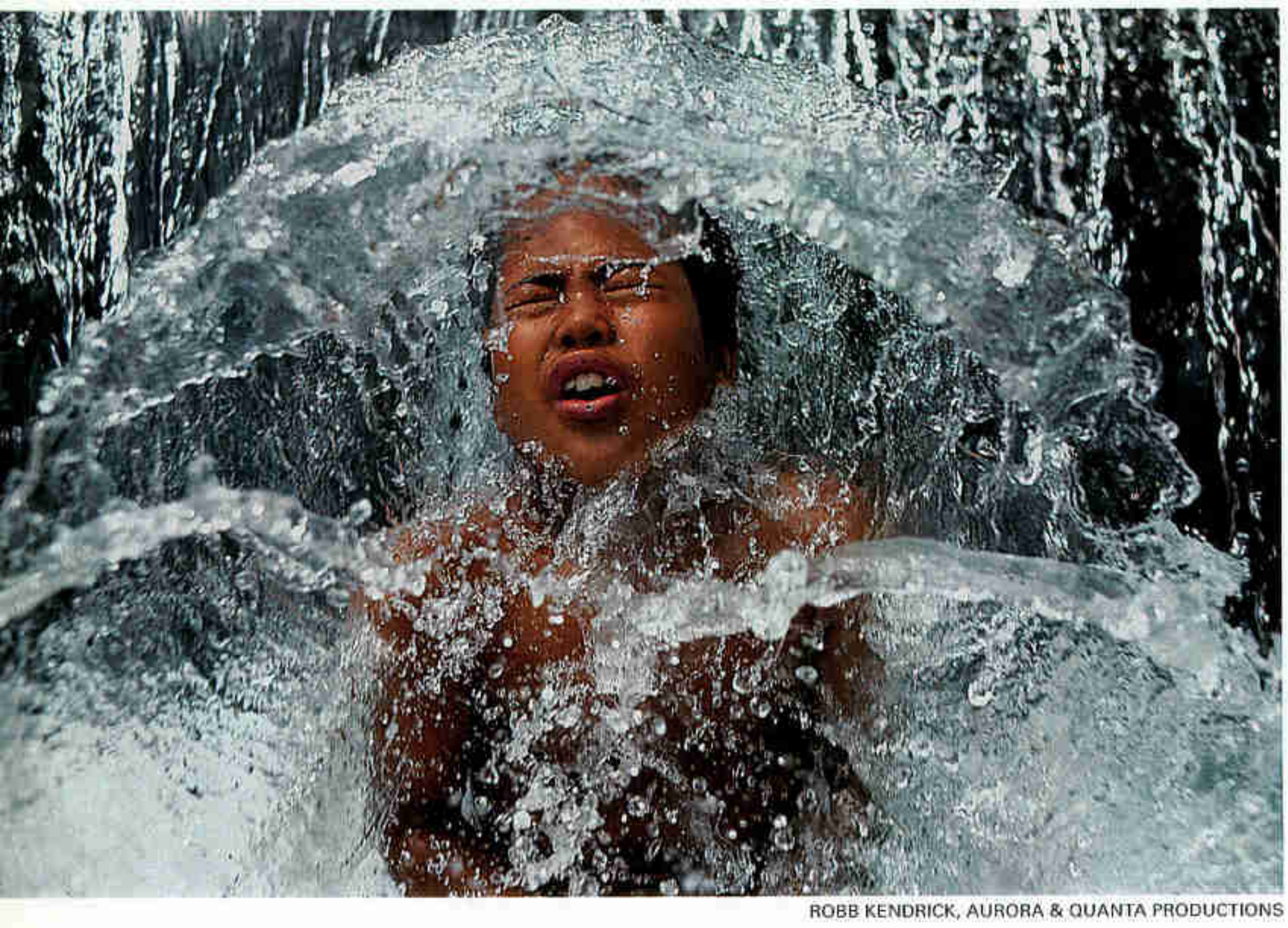
In 1994, Bulondo told me, hordes of refugees fleeing civil war in neighboring Rwanda flocked to the shores of Lake Kivu. Frightened and famished, they swept down on Nzulu's maize and vegetable fields by the tens of thousands, eating everything and leaving Bulondo and his people with no food and no seed for the next planting. It took two years of hunger and hard work before the village had another crop, and that crop was stolen by soldiers fighting the Zairean civil war in 1996. This year wandering troops from both sides of that war have been raiding fields at gunpoint. "We have people here, good farmers, who no longer plant," Bulondo said. "Even if they do the work, they figure some army will come by and steal their harvest."

Towns and villages all over central Africa have suffered from political turmoil. In response, international agencies and volunteer groups have flocked to the region to feed the afflicted. I met many of these volunteers in Africa—people who left lives of comfort in Japan or Germany, London or Louisville to live in faraway villages and help others—and was inspired by their example. And yet, I found many of them to be conflicted.

"Sure, it's good that we're here helping hungry people get food," said Merry Fitzpatrick, a former Air Force officer from North Carolina who worked with Food for the Hungry in the Democratic Republic of the Congo. "But relief work is a Band-Aid. And the wound here goes too deep for a Band-Aid. The real problem is people hating people and the political games that result from hate. If the politics were ever settled, Africa would feed itself just fine."

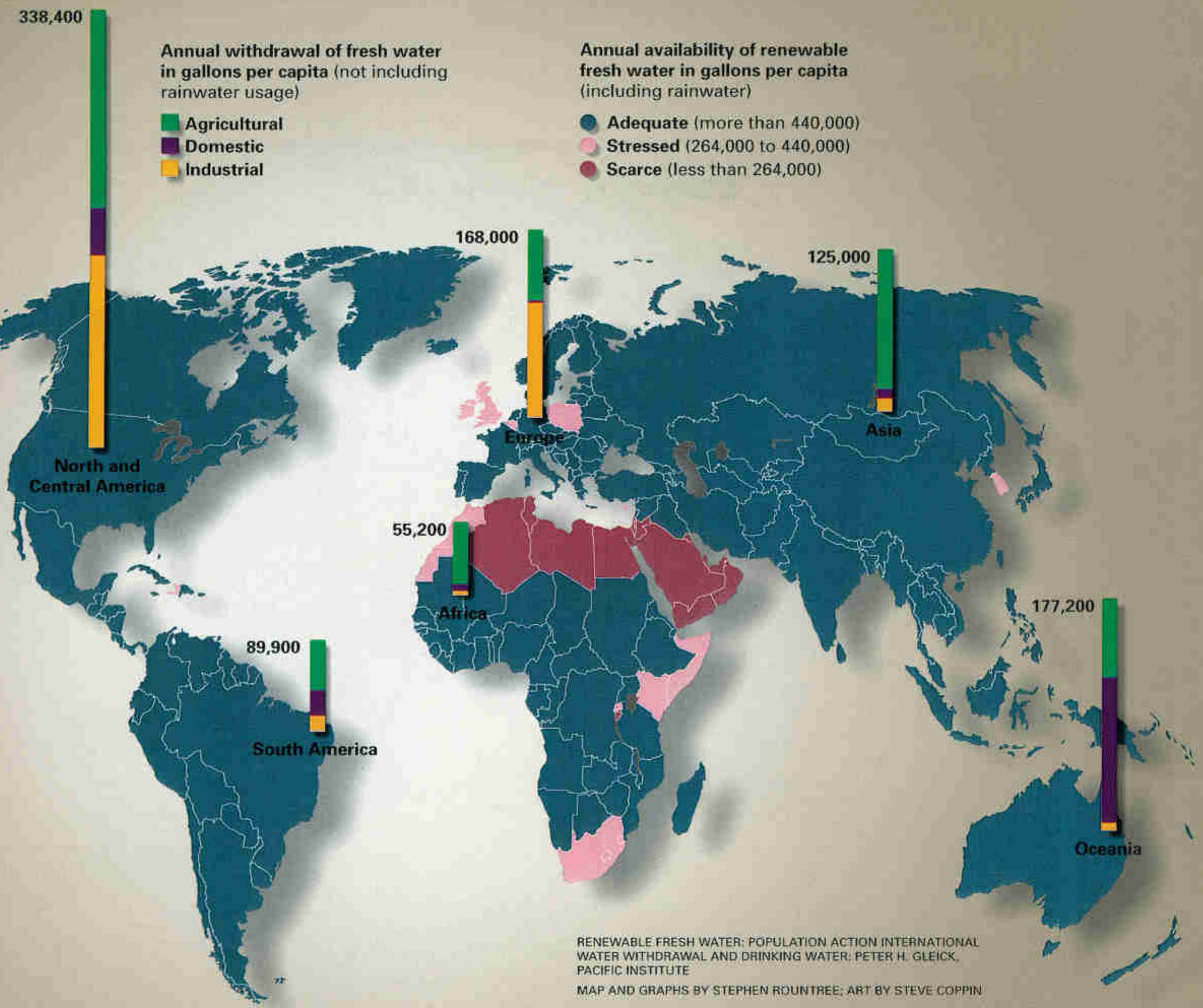
THE RELATIONSHIP between politics and food supply is reflected in the late 20th-century downs and ups of China, which has more mouths to feed than any nation on Earth. During Mao Zedong's Great Leap Forward of the late 1950s, China was ravaged by famines that killed tens of millions and reduced average calorie intake far below the recommended level. Today, with a market-oriented economy that has produced the world's highest growth rates, some Chinese have a different food problem.

"It's amazing to say, but our problem is becoming overnutrition," says Ho Zhiqian, a friendly, talkative nutrition expert on the government's National Food Advisory Commission. "Today in China obesity is becoming common. We have more diabetes than the United States. Breast cancer is multiplying. I believe these are related to consumption of animal fat—you know, eggs, meat, butter—as a normal part of the daily diet."



ROBB KENDRICK, AURORA & QUANTA PRODUCTIONS

Water refreshes a boy in Bali, Indonesia, as it cascades in an aqueduct that irrigates rice fields. Close to its source, a volcanic lake, this water runs clean. As it flows from one field to the next, though, it accumulates fertilizers and pesticides. In agriculture as well as in domestic and industrial settings water moves from use to use, and with each cycle it becomes more contaminated. Purifying it after such hard use is difficult and expensive.



Preserving the essence of life

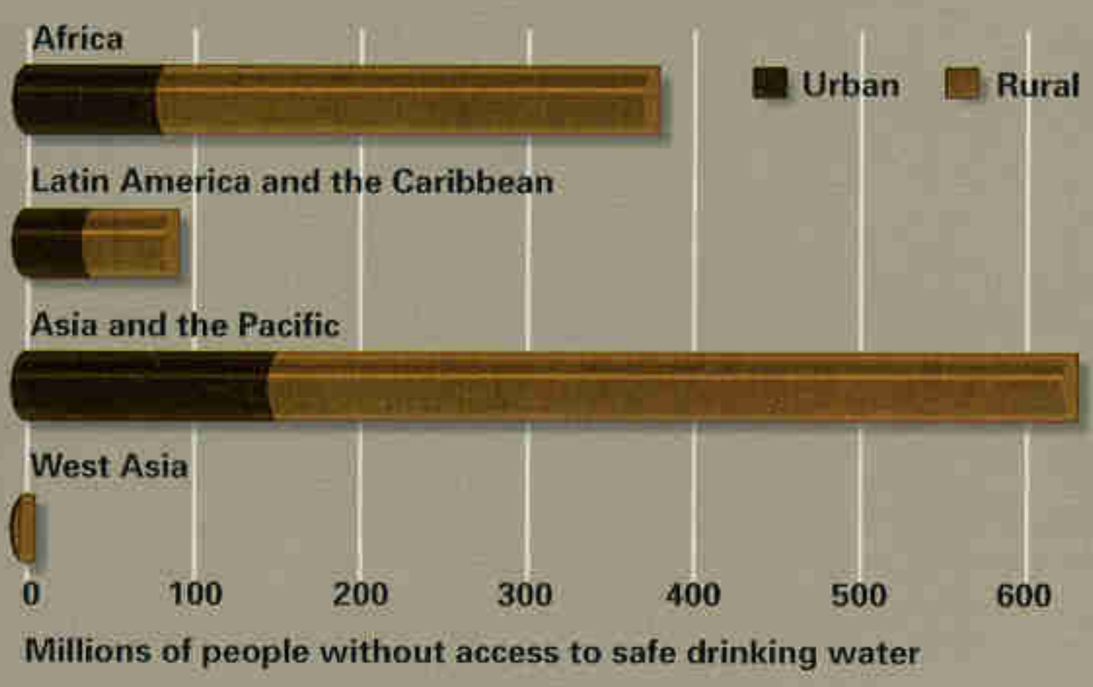
Once considered an unlimited resource free for the taking, clean water is becoming a scarce and valuable commodity. Though most countries still have adequate supplies, as illustrated above, continued depletion of wells and springs, wasteful use, and pollution will reduce what is available in the future.

As economies in Asia, Africa, and Latin America develop, competition for water between industry and agriculture will likely intensify, driving up its cost. With more than a third of the world's harvest grown on irrigated land, price wars over water can make food more expensive. In addition, modern agriculture requires more water than any other activity, accounting for 70 to 80 percent of all use. If farmers are forced to cut back, they will have to find new agrarian strategies.

In the past, dams, reservoirs, and aqueducts delivered water to meet increased demand. Today, however, economic and environmental costs generate opposition to new construction in many places. To have enough water in the long run, we now must pay more attention to using it efficiently and keeping it cleaner as we do so.



The developing world's drinking glass is only part full. Lack of infrastructure keeps a quarter of that population from getting safe water. As a result, five to ten million people die each year from water-related diseases such as cholera.



Torn from their homes by civil war, hungry children get protein and fluid from porridge at a refugee camp in the Democratic Republic of the Congo. "This area, North Kivu, is the country's breadbasket," says Monty Crisp, country director of Food for the Hungry. "The tragedy is, we



have people in these therapeutic feeding centers solely because of the fighting." Children here eat every three hours. Around the world millions of chronically undernourished children are stunted mentally and physically and left especially vulnerable to disease. Each day 19,000 die.

Life's eternal circle is certain: Just as there is death—marked in India by pyres on the Ganges—so there is birth, bringing more hungry mouths into the world. "It is possible to feed them all," says Second Harvest's Christine Vladimiroff. "We have the wisdom and the resources. I wonder if we can find the compassion and the international political will to accomplish it."

Today's increasingly prosperous China can afford meat. The Chinese already eat about as much pork per capita as Americans do; chicken and beef consumption is also climbing fast. This changing diet has forced big changes in Chinese agriculture. To meet the needs of 1.2 billion consumers, the nation is moving away from the traditional communal plots to Western-style agribusiness. I saw that change for myself at China's largest chicken farm, the Shanghai Dajiang company's operation in Songjiang, a town about an hour's drive south of Shanghai.

The place is not so much a farm as a factory, with massive conveyor belts carrying fuzzy day-old chicks by the tens of thousands. Its feeding sheds hold 20,000 birds apiece. The chickens are fattened on carefully formulated feed; after 49 days of steady eating, they themselves become food.

Dajiang sells a million chickens a week. Most go to China's new supermarkets, but a growing percentage are shipped to the company's retail arm, Fast Food Dajiang, which competes directly with the country's most popular restaurant franchise, Kentucky Fried Chicken.

"When we opened the factory we were really aiming at export sales to Japan," Liu Jian, a Dajiang executive, told me as he munched on a soy-marinated drumstick at one of Fast Food Dajiang's outlets. "But now the Chinese demand is so strong that our market is overwhelmingly domestic."

For a Western hamburger lover like me, it seems almost churlish to complain if Chinese people, too, want meat on the table. But in global terms there is real concern about this shift. A meat-centered diet is an inefficient use of resources because you have to feed the animal before it's fed to people. To reach slaughter weight at 240 pounds, for example, a U.S. pig consumes some 600 pounds of corn and 100 pounds of soybean meal. The retail meat yield from that animal would provide a person with the UN's recommended 2,200 minimum daily calories for about 49 days. Eating the corn and soybean meal directly, the same person would have enough food for more than 500 days.

CAN CHINA PRODUCE ENOUGH grain to feed enough livestock to satisfy a billion meat-eaters? Many economists and agricultural experts fear not. If China becomes a dramatically larger net buyer—and it's already among the world's greatest grain importers—that may raise prices for every other hungry country.

The Chinese insist that the world's most populous country can feed itself. They note proudly that they have more than tripled domestic grain production over the past half century. Wherever I went in China, officials showed me plans to expand the supply of arable fields—by terracing hillsides, converting parks and cemeteries, even creating new land. They convinced me that China has found the political will to make sure its people are fed, a commitment that is commonplace in Western democracies but one I did not find in Africa.

I was reminded of that difference during a luncheon with Ho Zhiqian, the friendly nutrition expert. Ho is a professor at Sun Yat-sen Medical University in Guangzhou, and he looked the part: gold wire-rimmed glasses, V-neck sweater, striped tie, and a button-down collar he had left unbuttoned. A Guangzhou booster, Ho suggested we dine on some of the city's famous culinary specialties.

Lunch was fabulous. We had fresh shrimp, braised sea bass, chicken with bean sprouts, spicy pork ribs, and succulent fried rice. By the final course we were so stuffed that my question seemed utterly superfluous, but I turned to my host and asked him anyway. Can the Earth continue to feed its growing population?

"Oh, Mr. Reid, you've asked the wrong person," the professor replied in his amiable way. "I've devoted my life to the study of food supplies, diet, and nutrition. But your question goes way beyond those fields. Can the Earth feed all its people? That, I'm afraid, is strictly a political question." □

T. R. Reid writes about fresh water and how pressures produced by population growth affect the resources available for drinking, sanitation, industry, and agriculture at *www.nationalgeographic.com/features/2000/population/planet.*





Lewis and Clark

NATURALIST-EXPLORERS

BY RON FISHER

Every day brought something new. A stately pronghorn, perhaps, watchful under darkening skies. Or a new plant—the vine maple—its leaf sketched onto a journal page (above). As Meriwether Lewis and William Clark led their expedition into the Louisiana territory in 1804, discoveries piled up: "Parrot queets" one day, "Leek Green Grass"—big bluestem—the next. To Lewis the wilderness seemed "one emence garden."

NATIONAL GEOGRAPHIC PHOTOGRAPHER SAM ABELL; PORTRAITS: CHARLES WILLSON PEALE, INDEPENDENCE NATIONAL HISTORICAL PARK; LEAF: MERIWETHER LEWIS, AMERICAN PHILOSOPHICAL SOCIETY, PHILADELPHIA

"... Porcupin rabits

IN THE UNITED STATES in 1800 there were no grizzly bears. Or prairie dogs or cutthroat trout. No white-tailed jackrabbits or pronghorn. Or ponderosa pines. No sage grouse. Prairie falcons hunted elsewhere.

These particular bears and birds and trees and fishes—and scores more equally familiar—were all in a foreign place called Louisiana.

But by 1803 that had changed.

Soon after President Thomas Jefferson acquired the Louisiana Purchase in April 1803, Meriwether Lewis and William Clark and their Corps of Discovery set out to see what was there, and like magicians pulling rabbits from a hat, the two men made wonderful things appear.

The highlights of the expedition are familiar: the assembling of a group of "robust . . . helthy hardy young men"; the struggle up the roiling Missouri River; the lone death, unlucky Sergeant Floyd; winter among the Mandan Indians in North Dakota; Sacagawea and her baby; the crossing of the Eden-like Great Plains and the portage around the Great Falls of the Missouri; the Bitterroots; the descent of the Salmon and Columbia Rivers to the Pacific; the depressing winter at Fort Clatsop; and the return home.

The success of the expedition made Lewis and Clark famous as explorers, woodsmen, and military leaders, but their skills as scientists went unrecognized. At the end of the expedition Lewis announced that their journals would be published, including a volume "confined exclusively to scientific research, and principally to the natural history of those hitherto unknown regions." But he died before the volume was completed, and it never appeared. The world was left with the image of Lewis and Clark as courageous adventurers.

It would be a century before it became generally known that during their epic journey Lewis and Clark recorded hundreds of plants and animals that, though intimately familiar to the nations of Indians living in the American West, were new to science.

And it's only now, with the publication of a multivolume work by the University of Nebraska, that a comprehensive picture of the contribution of Lewis and Clark is emerging—nearly 200 years after the expedition. Gary E. Moulton, professor of history at Nebraska and editor of the journals, says, "Lewis and Clark provided us with a record of the biota of the trans-Mississippi West that is as close as we can get to seeing it in its natural condition—before all the plowing and planting by Euro-Americans. They brought back a remarkable record of it."

Jefferson's instructions to the explorers were detailed, having to do mostly with finding a Northwest Passage, but he was interested in every aspect of the land. Observe, he instructed them, "the face of the country, it's growth & vegetable productions . . . the animals of the country generally, & especially those not known in the U.S." Observe, he wrote, "the dates at which particular plants put forth or lose their flowers, or leaf, times of appearance of particular birds, reptiles or insects."

Of the two men who pushed off up the muddy Missouri River on May 21, 1804, at the head of their party, Lewis was the better naturalist but Clark the more accomplished geographer and *(Continued on page 84)*

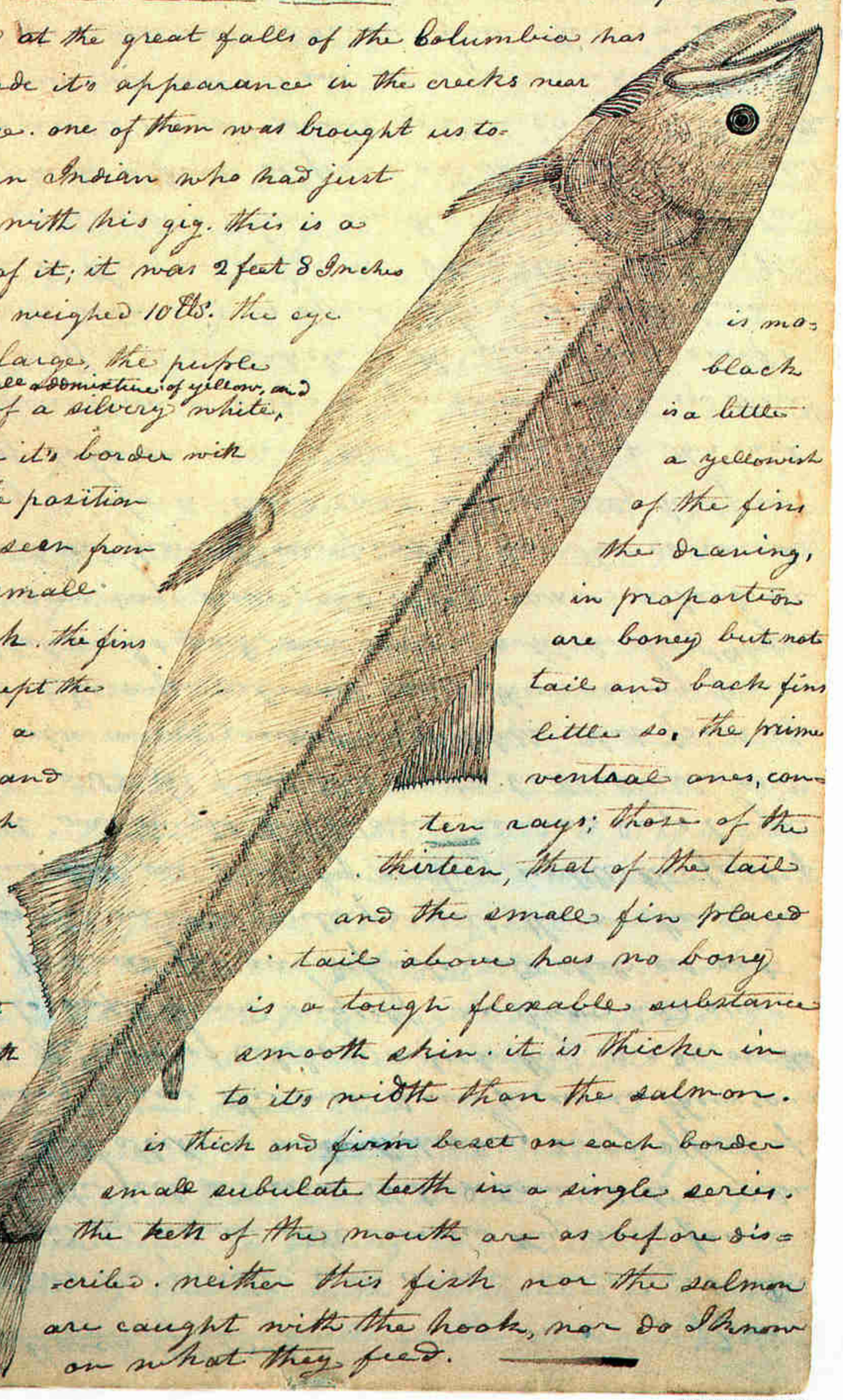
RON FISHER first wrote about Lewis and Clark in 1970 and has been an enthusiast ever since. Over the years he has visited many of the expedition's sites—from St. Louis to the snows of North Dakota and the cold drizzle of the Oregon coast.

Adrift in a sea of prose, a coho salmon sprawls across a page of Lewis's journal. Indians gigged the two-foot-eight-inch, ten-pound fish near the expedition's winter quarters on the Pacific coast. "This is a likness of it," Lewis wrote.

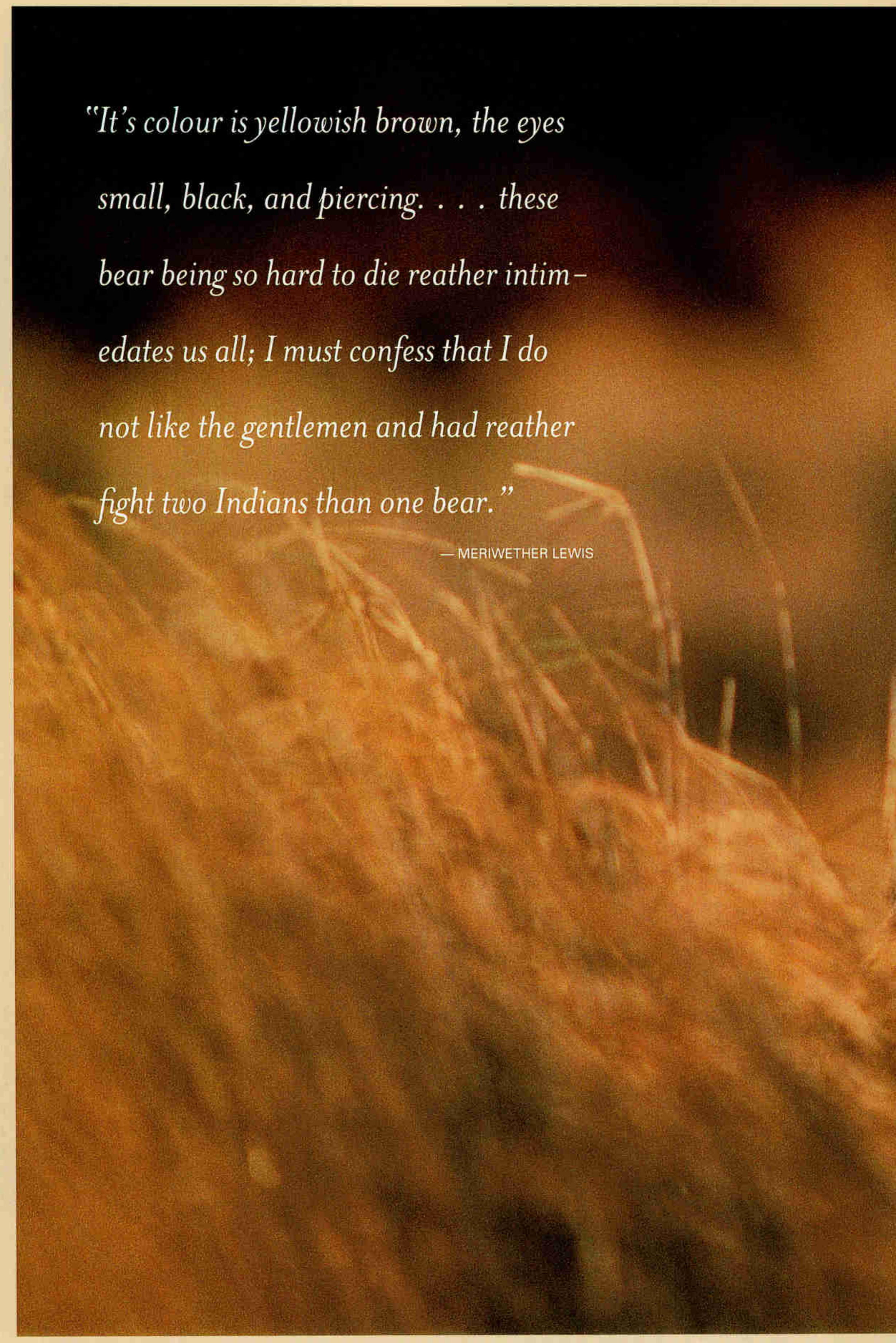
& Barking Squirils"

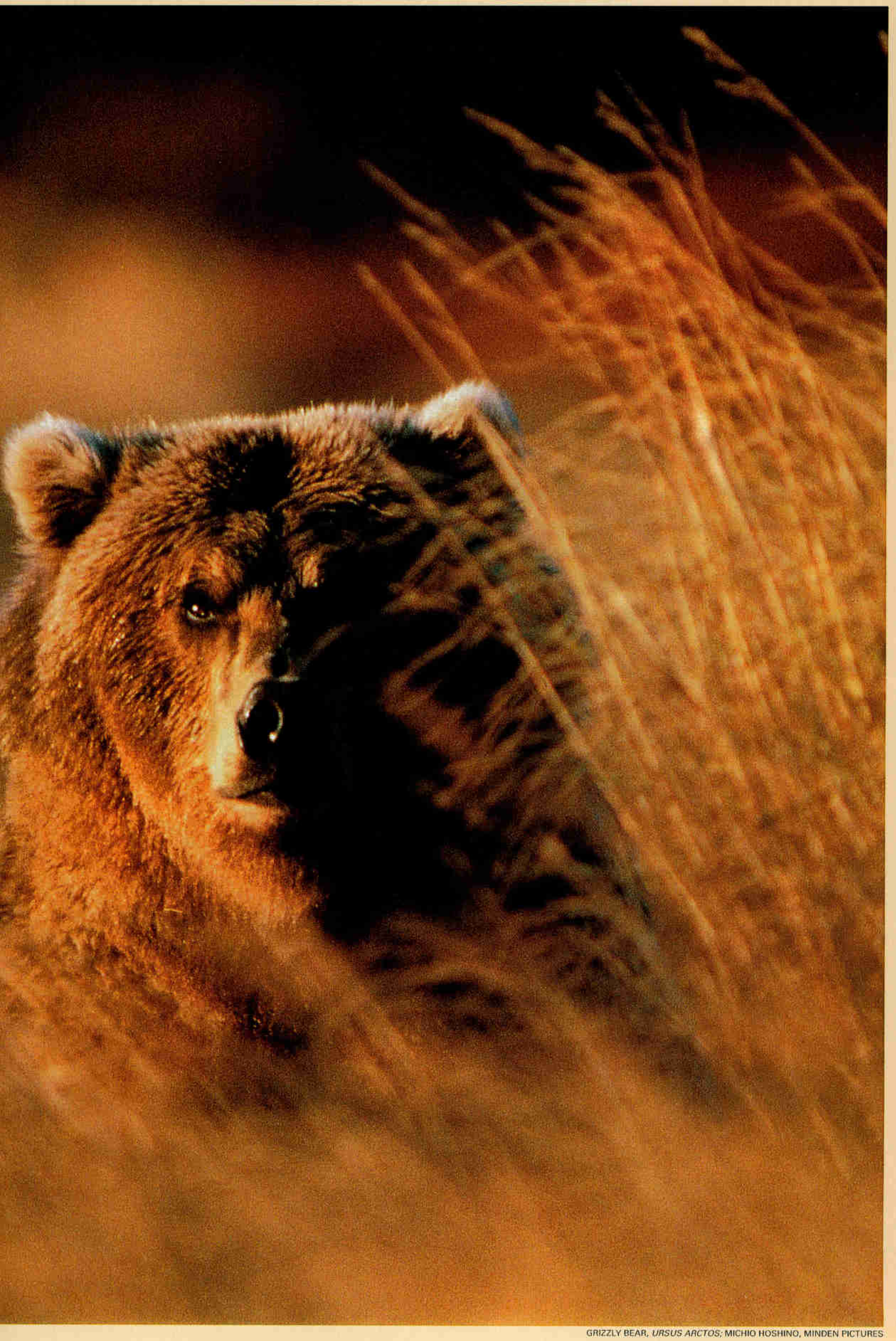
the rocks. the shell is thin and consists of one valive. a small circular apperture is formed in the center of the under shell. the animal is soft & boneless. -

The white Salmon Trout which we had previously seen only at the great falls of the Columbia has now made it's appearance in the creeks near this place. one of them was brought us to-day by an Indian who had just taken it with his gig. this is a likeness of it; it was 2 feet 8 Inches long, and weighed 10 lbs. the eye is moderately large, the pupple with a small admixture of yellow, and and iris of a silvery white, black verbid near it's border with is a little brown. the position a yellowish may be seen from of the fins the draning, they are small in proportion to the fish. the fins are boney but not pointed except the tail and back fins which are a little so. the prime back fin and ventral ones, con- tain each ten rays; those of the gills thirteen, that of the tail twelve, and the small fin placed near the rays, but tail above has no boney covered with is a tough flexable substance proportion smooth skin. it is thicker in the larger to it's width than the salmon. with is thick and firm beset on each border small subulate teeth in a single series. the teeth of the mouth are as before dis- cribed. neither this fish nor the salmon are caught with the hook, nor do I know on what they feed. ———



MERIWETHER LEWIS


"It's colour is yellowish brown, the eyes
small, black, and piercing. . . . these
bear being so hard to die reather intim-
edates us all; I must confess that I do
not like the gentlemen and had reather
fight two Indians than one bear."
— MERIWETHER LEWIS



GRIZZLY BEAR, *URSUS ARCTOS;* MICHIO HOSHINO, MINDEN PICTURES



10. SALMONBERRY
Rubus spectabilis

". . . a dryed fruit which resembled the raspburry. . . ."
March 27, 1806, mouth of the Cowlitz River, Washington



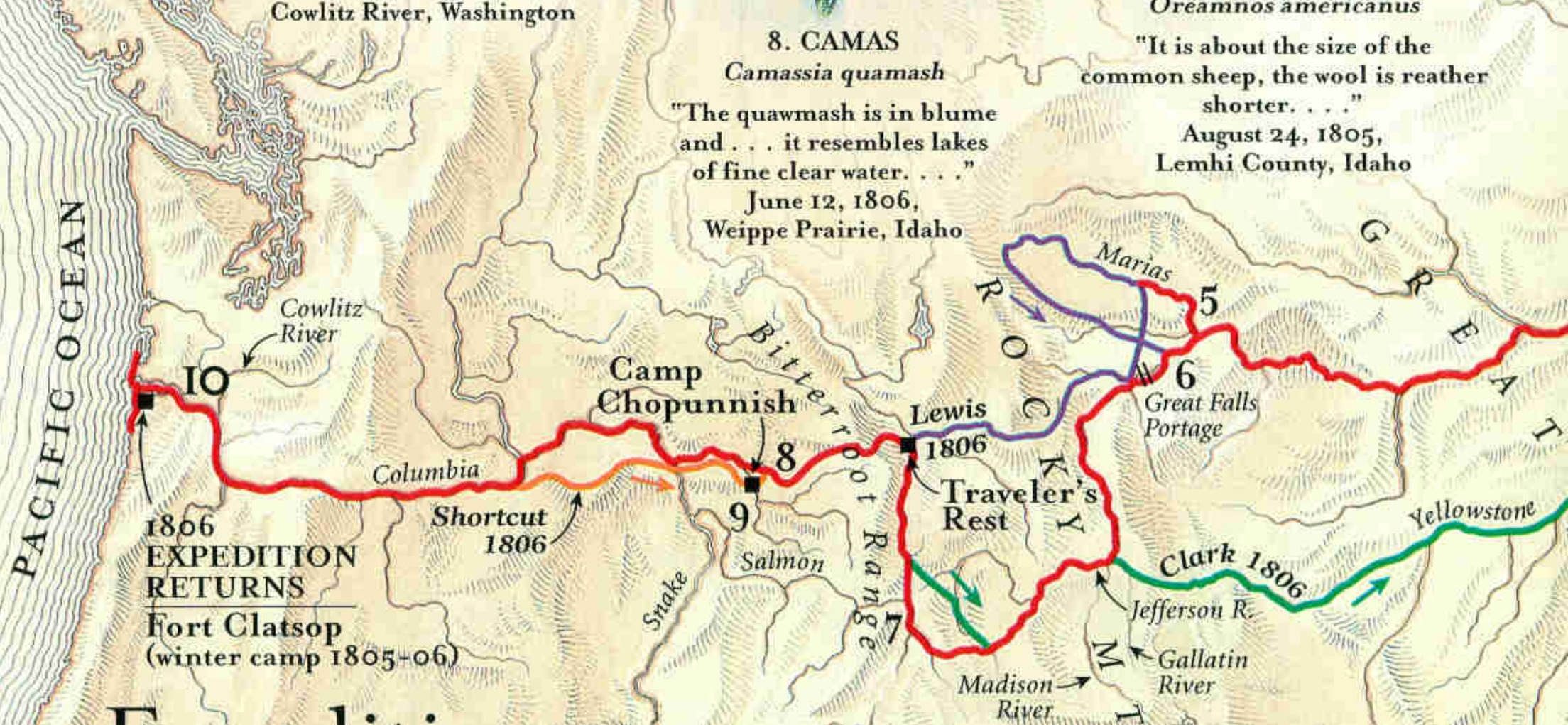
8. CAMAS
Camassia quamash

"The quawmash is in blume and . . . it resembles lakes of fine clear water. . . ."
June 12, 1806, Weippe Prairie, Idaho



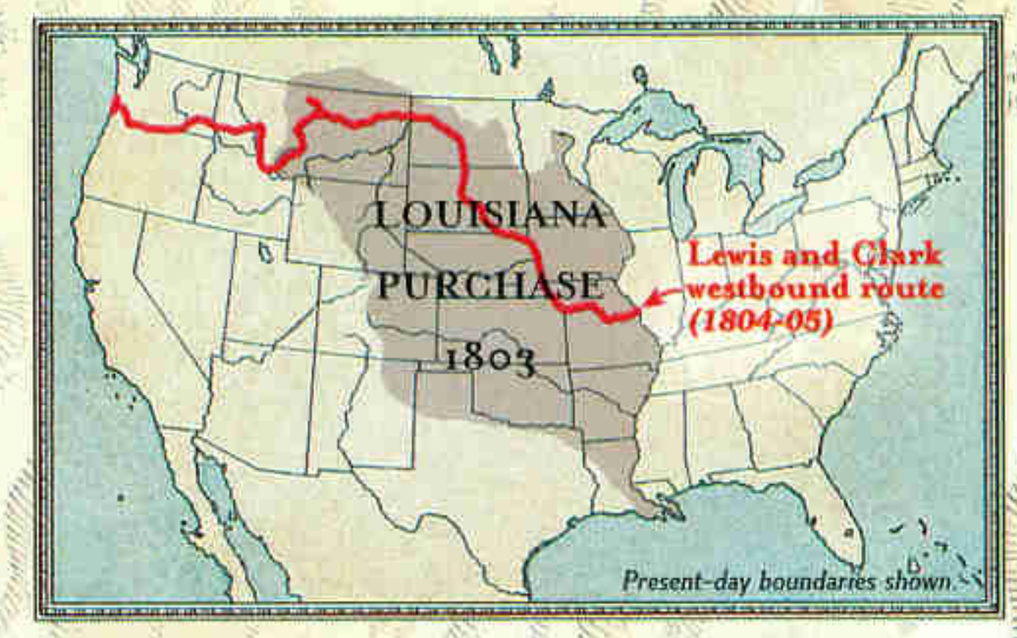
7. MOUNTAIN GOAT
Oreamnos americanus

"It is about the size of the common sheep, the wool is reather shorter. . . ."
August 24, 1805, Lemhi County, Idaho



Expedition of discovery

From St. Louis to the Pacific Ocean and back—some 8,000 miles of travel in 28 months—Meriwether Lewis and William Clark crossed the territory of the newly acquired Louisiana Purchase. President Thomas Jefferson hoped that the explorers would find an easy water route to the Pacific, but he also urged them to take note of the flora and fauna of the new region. Amateur naturalists but careful observers, they described hundreds of plants and animals previously unknown to science. Three of the plants they recorded would become state flowers: the mock orange in Idaho, the bitterroot in Montana, and the Oregon grape.





9. WESTERN TANAGER
Piranga ludoviciana

"We meet with a beautifull little bird in this neighbourhood."
June 6, 1806, Camp Chopunnish, Idaho



5. SAGE GROUSE
Centrocercus urophasianus

"I saw a flock of the mountain cock. . . ."
June 5, 1805,
Marias River, Montana



4. WHITE-TAILED JACKRABBIT
Lepus townsendii

"Shields Killed a *Hare* . . . clearly the mountain Hare of Europe."
September 14, 1804, near Chamberlain, South Dakota



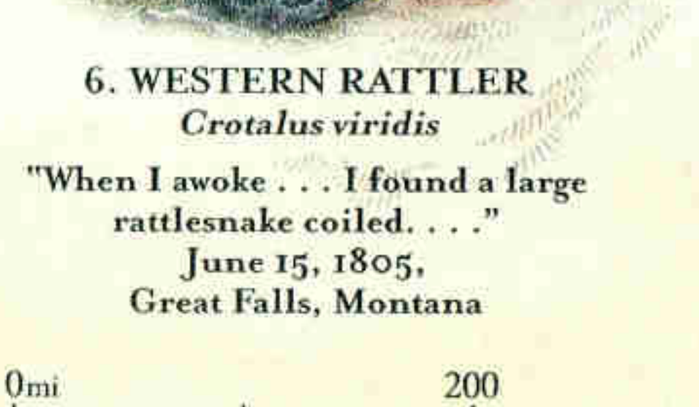
2. MISSOURI BEAVER
Castor canadensis

". . . a large Pond Containg Beever."
July 3, 1804, near Iatan, Missouri



1. COTTONWOOD
Populus deltoides

"The Cotton wood begin to obtain . . . a Greenish Cast at a distance. . . ."
April 17, 1804,
St. Charles, Missouri



6. WESTERN RATTLER
Crotalus viridis

"When I awoke . . . I found a large rattlesnake coiled. . . ."
June 15, 1805,
Great Falls, Montana



3. BLACK-TAILED PRAIRIE DOG
Cynomys ludovicianus

". . . discovered a Village of an annamale . . . which burrow in the grown. . . ."
September 7, 1804,
Boyd County, Nebraska

Point of reunion
August 12, 1806

Ft. Mandan
(winter camp 1804-05)

Sergeant Floyd's gravesite

1804 EXPEDITION BEGINS

Camp Wood
(winter camp 1803-04)

St. Louis

Lake Superior

Lake Michigan

Little Missouri

Cheyenne

Niobrara

Missouri

Vermillion River

Platte

Kansas

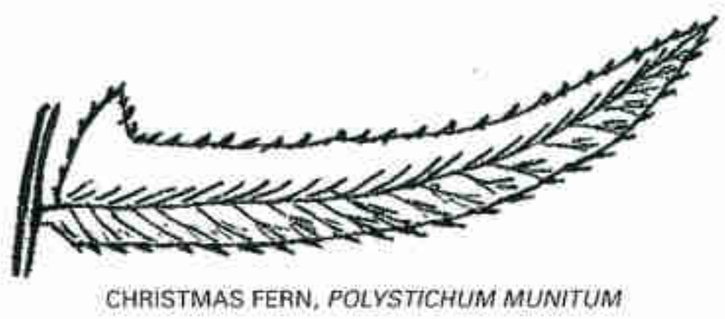
Osage

Mississippi

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NATIONAL GEOGRAPHIC MAPS
ART BY LASZLO KUBINYI



CHRISTMAS FERN, *POLYSTICHUM MUNITUM*

(Continued from page 78)

cartographer. Though firm friends, the two men had distinct personalities: Lewis tended to be moody and introverted, while Clark was more outgoing.

Their supplies included "6 Papers Ink Powder"—which they mixed with water to make ink—and "100 Quils." During the day they made rough field notes, and when time allowed they wrote in their journals. And write they did. Historian Donald Jackson called them the "writingest explorers of their time. They wrote constantly and abundantly, afloat or ashore, legibly and illegibly, and always with an urgent sense of purpose."

And as they made their way up the Missouri, even in the early days marvels began to appear. Just a week after setting out, according to Clark, "Capt Lewis went out to the woods & found many curious Plants & Srubs." He listed several thought to have medicinal value, like the silver-leaf scurf pea, "said to be good for inflamed eyes."

They also recorded their first new mammal. Clark wrote: "Several *rats* of Considerable Size was Cought in the woods to day"—the eastern wood rat. Lewis added that it had "the distinguishing trait of possessing a tail covered with hair like other parts of the body."

Clark recognized that he was passing through a region that cried out for description by a botanist and a naturalist. "The Praries Contain Cheres, Apple, Grapes, Currents, Rasp burry, Gooseberris Hastlenuts and a great Variety of Plants & flours not Common to the U S. What a field for a Botents and a natirless."

EARLY MORNING FOG hangs above the Jefferson River in Montana. "Lewis camped here on a gravel bar," says Stuart Knapp, pointing, "and killed a blue grouse."

I spend a few days with Stu, a local Lewis and Clark buff, retracing the explorers' route. Where we stop to stretch our legs, chipmunks chatter. Driving along, we see a bald eagle sitting on a fence post, watched over by three nervous magpies, and a golden eagle soaring overhead. Sandhill cranes, creaking like rusty hinges, share a pasture with half a dozen mule deer. Nearby, pronghorn lope along a grassy hillside. Lewis wrote: "The superior fleetness of this anamal . . . was to me really astonishing . . . it appeared reather the rappid flight of birds than the motion of quadrupeds."

And not far away a herd of bison graze in a pasture owned by billionaire Ted Turner.

Near the mouth of the Vermillion River in South Dakota, Clark had reported, "Fields Sent out to hunt Came to the Boat and informed that he had Killed a Buffalow in the plain a head."

Lewis and Clark did not discover the American bison, whose territory once had extended eastward to the Allegheny Mountains and beyond, but neither of them had ever seen one. Suddenly the creatures were common, and the explorers were among the first to comment on the great numbers. Clark wrote: "I assended to the high Country and from an eminance I had a view of. . . . near 20,000 of those animals feeding on this plain." He noted that one day they had to wait an hour while a herd crossed the river in front of them.

Despite the bisons' powerful appearance, the animals were docile. Lewis found them "so gentle that the men frequently throw sticks and stones at them in order to drive them out of the way."

Bison still roam here, though in reduced numbers. "This is near where Lewis and Clark's men first killed a buffalo," says Larry Mason. He and his wife, Rose, and his brother Monty operate Tarbox Hollow Living Prairie, just 15 miles from the Missouri in northeastern Nebraska. A couple of hundred bison, as stolid and brown as boulders, graze in their pastures. They're marketed for their meat and hides, but tourists also come to see them.

Venture into the herd in a pickup and the hairy creatures come jogging up, expecting to be handed alfalfa-and-molasses treats the size



MERIWETHER LEWIS (OPPOSITE); LEE RENTZ

Lewisia rediviva, *the bitterroot (above), commemorates its discoverer. Although the Shoshone relished the steamed roots, Lewis found them "naucious to my pallate." Clark was honored in the naming of* Clarkia pulchella, *or ragged robin, an evening primrose.*

and shape of shotgun shells. Enormous heads come right in the pickup window, and huge, raspy black tongues wrap around the treats and around the treaters' fingers as well. Their eyes roll back in their heads as they reach. Their woolly foreheads feel dusty and rough.

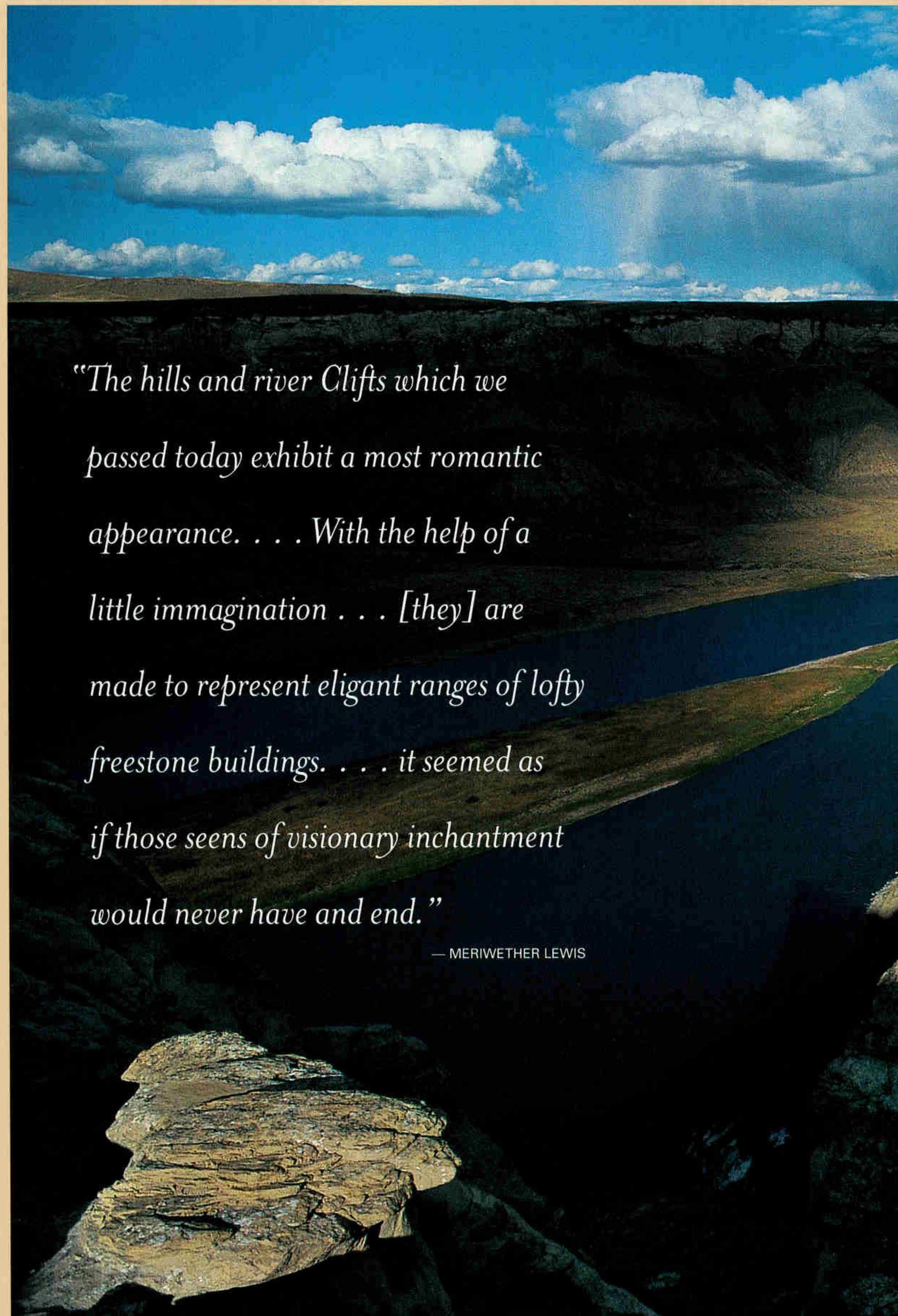
"Notice that there's no smell and no noise," says Larry, and it's generally true: The strong barnyard odor is missing, and the animals are eerily quiet. They're all named Buffy, Rose tells me.

Larry rattles off the good things about raising bison. "They produce more income than beef cattle," he tells me. "They're a very efficient animal. They eat less than cattle, don't need shade in the summer or shelter in the winter. They were designed for survival out here on the Great Plains. They never have trouble calving. And when buffalo put fat on, they put it between the meat and the hide, not marbled into the meat like cattle, so their meat is lean and low in cholesterol."

It was not far from Tarbox Hollow that Lewis and Clark first noticed another ubiquitous animal of the plains. Lewis called it a barking squirrel because he thought its call was "much that of the little toy dogs." One of the sergeants—John Ordway, who was also keeping a journal—may have been the first person to call it by the name we know today: the prairie dog. Clark wrote: "The Village of those animals Covs. about 4 acrs of Ground on a Gradual decent of a hill and Contains great numbers of holes on the top of which those little animals Set erect make a Whistleing noise and whin allarmed Slip into their hole."

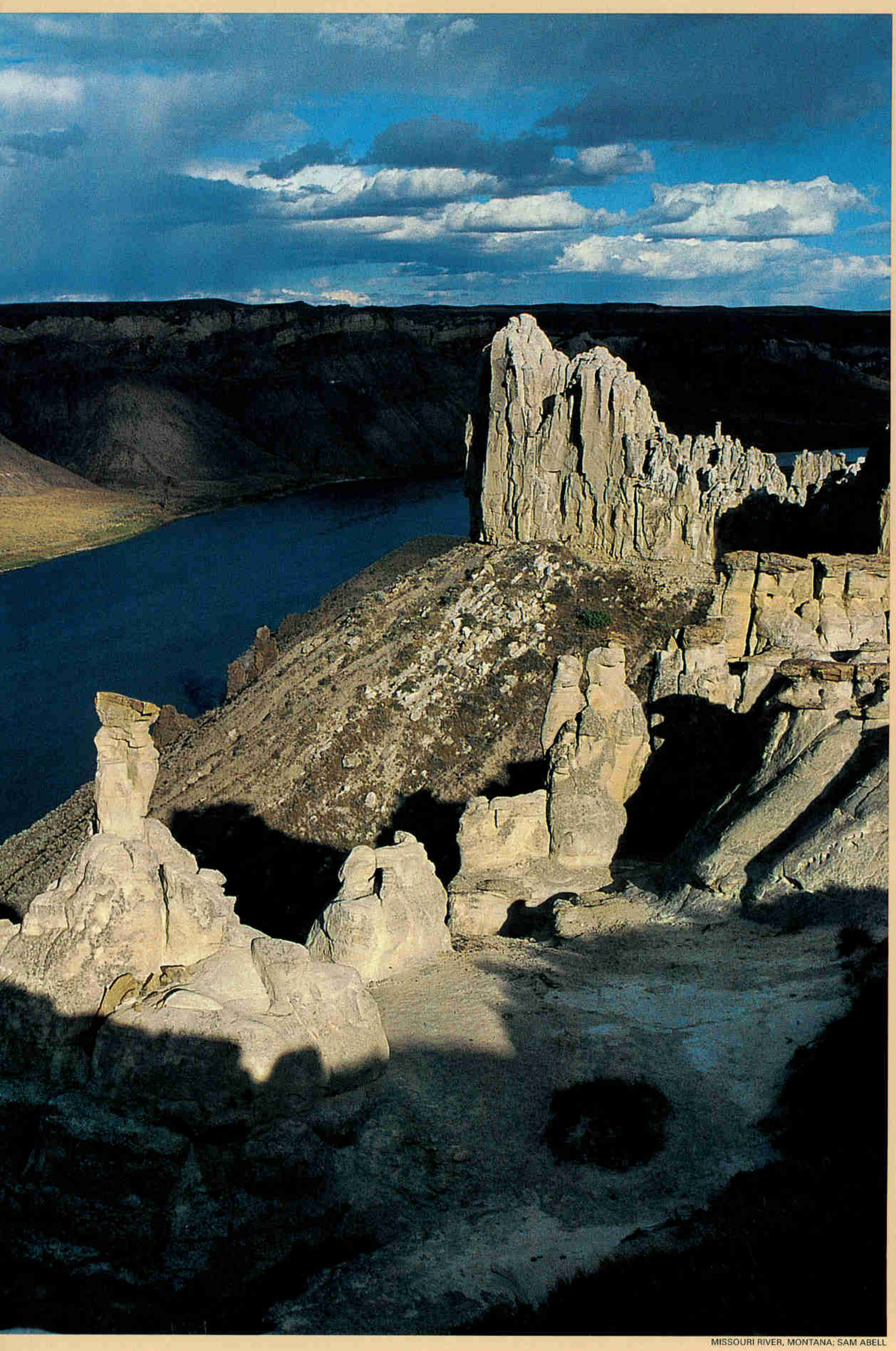
The men were intrigued by prairie dogs and worked hard one day at collecting a specimen. They poked and prodded and dug six feet down with no luck, then tried flooding. Everyone but one or two men left guarding the boats hauled buckets of water from the river. "We por'd into one of the holes 5 barrels of water without filling it," wrote Clark.

Lewis's observations of the prairie dog were precise and accurate: "They generally seelect a south or south Easterly exposure for their residence, and never visit the brooks or river for water; I am astonished at how this anamal



"The hills and river Clifts which we passed today exhibit a most romantic appearance. . . . With the help of a little immagination . . . [they] are made to represent eligant ranges of lofty freestone buildings. . . . it seemed as if those seens of visionary inchantment would never have and end."

— MERIWETHER LEWIS



MISSOURI RIVER, MONTANA; SAM ABELL



MERIWETHER LEWIS (OPPOSITE); CHARLES SLEICHER, TONY STONE IMAGES

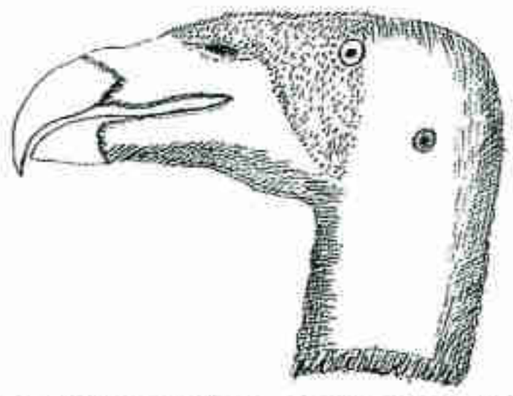
Flurries dust a captive western mountain lion in Montana. The explorers, familiar with the big cats of the Appalachians, called the animals panthers. "It is precisily the Same animal common to the Atlantic States," wrote Clark. The panthers were difficult to hunt, he added, being "So remarkable Shye and watchfull." Lewis and Clark devoted thousands of words in their journals to precise and colorful natural history observations, a scientific contribution long overshadowed by their adventures.

exists as it dose without water . . . we have sometimes found their villages at the distance of five or six miles from any water."

I take a seat one blustery October day at the edge of a prairie dog town in Montana, just back from the Yellowstone River. Clark and a party of the men descended the river during the expedition's return from the coast. A cold wind sends an overcast sky scudding. Scores of prairie dogs are out and about, looking fat and sleek as they prepare for winter.

I find that if I sit quietly, they feed practically at my feet. They're the color of the brown grass they're eating. They move along on all fours, picking up tidbits with one paw, nibbling. One suddenly stands on its hind legs and emits a squeak. They have dark brown eyes and tiny ears folded into their fur. A large one as fat as a football comes running up to another in a rocking-horse motion, and they touch noses, which looks like a kiss. Sometimes they stand peering around with a slight frown, their hands held in front of them, like Queen Elizabeth. One barks furiously when I depart. With each yelp its head bobs and its tail wags, which makes it look like a mechanical toy.

One prairie dog from the Lewis and Clark expedition made a remarkable journey. From their first winter quarters at Fort Mandan in North Dakota the corps sent it, along with a shipment of scientific specimens, back to Jefferson. After a journey of four months and 4,000 miles—down the Missouri and Mississippi Rivers to New Orleans, then by ocean-going sailing ship to Baltimore—the prairie dog reached Washington safely. It lived for a while in the President's House, then in the Peale Museum in Philadelphia. It survived



CALIFORNIA CONDOR, *GYMNOGYPS CALIFORNIANUS*

there for at least six months before passing quietly into history.

Sometimes Lewis noticed things other observers might have missed. He wrote hundreds of words of meticulous description of the mule deer, new to science, noting its size, summer and winter coats, antlers, habitat, mulelike ears and tail, and behavior. Then he described, on the inner corner of each eye, "a drane or large recepticle." This, the melancholy Meriwether Lewis thought, gave the mule deer "the appearance of weeping."

There came a day when up from the underbrush loomed a creature whose reputation had preceded it—the grizzly bear. The corps first encountered the grizzly near present-day Bismarck, North Dakota. The Indians had warned them of its strength and ferocity. On April 29, 1805, they shot and killed one in Montana. "The Indians may well fear this anamal, equiped as they generally are with their bows and arrows . . . but in the hands of skillfull riflemen they are by no means as formidable or dangerous as they have been represented."

In a few weeks, however, after his men had had a number of narrow escapes, Lewis would be referring to them as "those tremendious anamals." Several of the men, even Lewis himself, were chased up trees or into their canoes by wounded grizzlies. Lewis wrote: "I find that the curiossity of our party is pretty well satisfyed with rispect to this anamal."

Of the birds in the sky, Lewis noted "the peculiar whistleing" of one new to him and coined its popular name: the whistling swan. And they killed "a Buzzard of the large Kind" —a California condor, which measured nine and a half feet from wing tip to wing tip. In what is now Lewis and Clark County in Montana, Lewis "saw a black woodpecker. . . . a distinct species of woodpecker." Today it is the only bird named for Lewis—*Melanerpes lewis,* Lewis' woodpecker.

Not much later, in Idaho, Clark saw a "Bird of the wood pecker kind which fed on Pine burs"—*Nucifraga columbiana,* or Clark's nutcracker, the only bird named for him.

Avid and intense, Lewis used all five senses when examining new animals or plants. In his journals he reproduced phonetically the calls of new birds. And of sagebrush he wrote: "On these hills many aromatic herbs are seen; resembling in taste, smel and appearance, the sage, hysop, wormwood, southernwood, and two other herbs which are strangers to me; the one resembling the camphor in taste and smell, rising to the hight of 2 or 3 feet; the other about the same size, has a long, narrow, smooth, soft leaf of an agreeable smel and flavor; of this last the Atelope is very fond; they feed on it, and perfume the hair of their foreheads and necks with it by rubing against it."

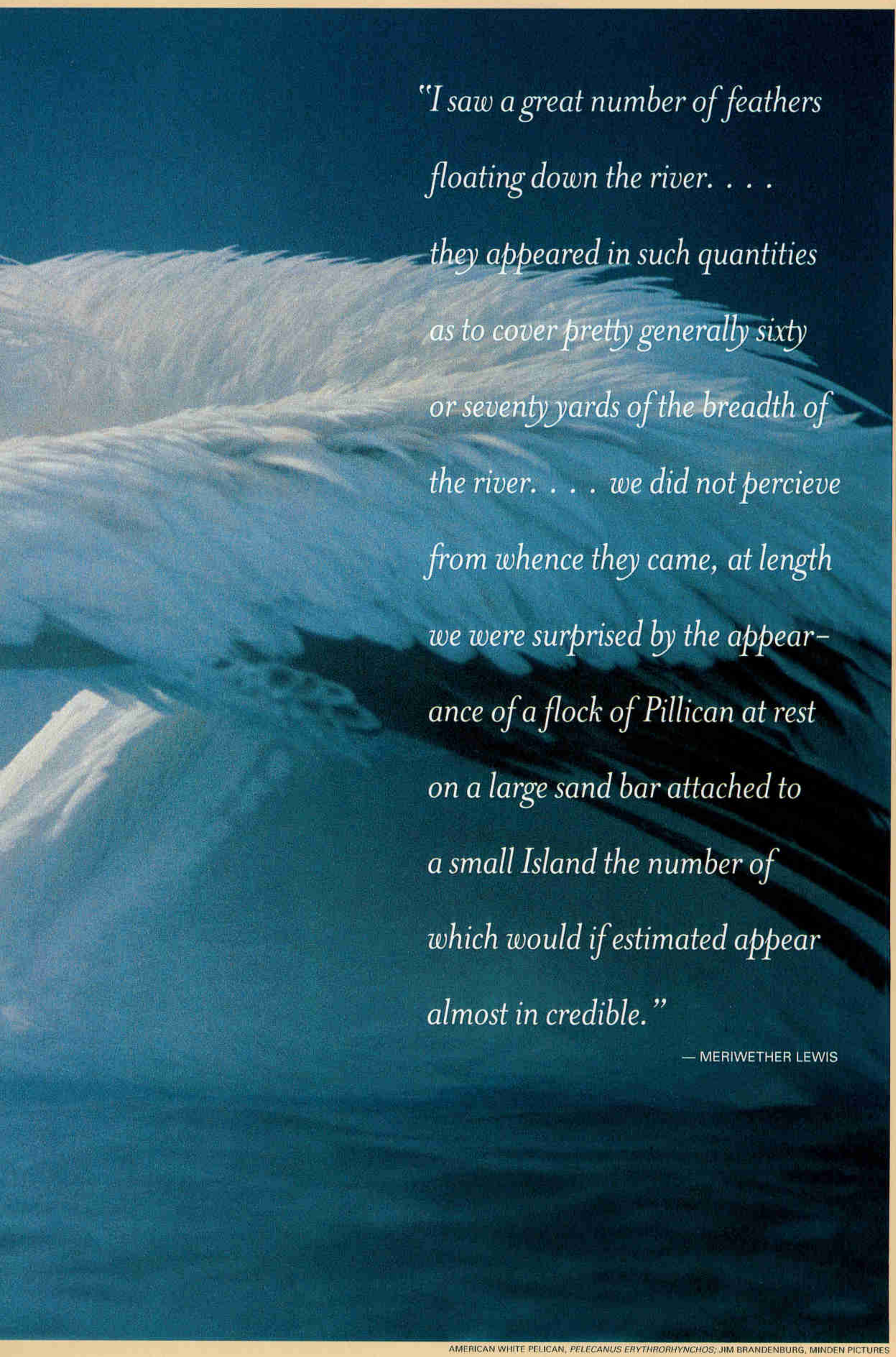
THROUGH THE PRAIRIES and the western plains, through mountains and river valleys, Lewis and Clark kept their collecting bags at hand. In addition to noting animals new to science, they collected dozens of plant specimens, drying and pressing them for the trip back east.

In Montana, Stu Knapp and I stop at Missouri Headwaters State Park, where the Jefferson, Gallatin, and Madison Rivers come together to form the Missouri. As we stroll through the sunny park, with crows cawing in the trees, Stu stops often to point out and gently touch what he calls "Lewis and Clark plants"—those species the captains brought back or described. Rabbitbrush, cudweed sagewort, blue bunch wheatgrass.

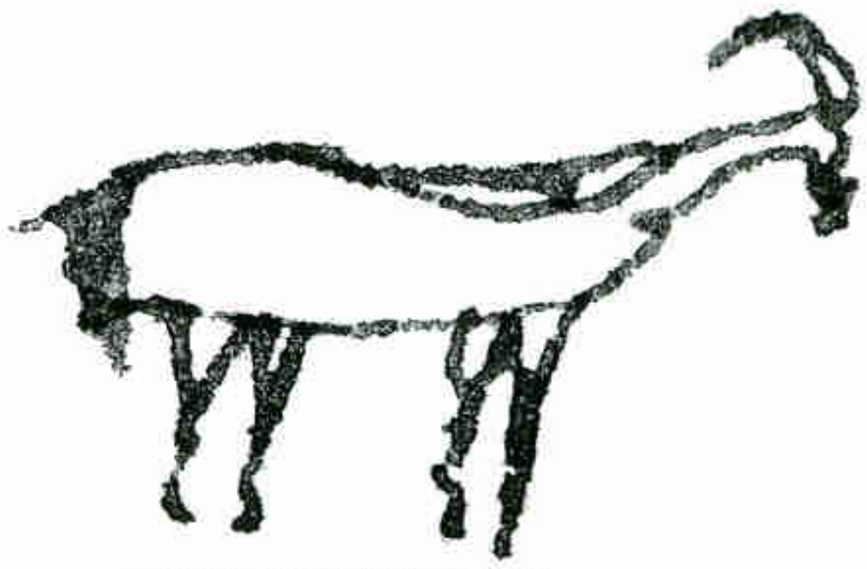
"This little bush is Rocky Mountain juniper," says Stu. "This is Woods' rose—*Rosa woodsii,* the western wild rose." Buffaloberry, greasewood, nipple cactus—Stu knows them all. "About 30 species of Lewis and Clark plants have been found just in this little park."

The plants they collected between their winter quarters in North Dakota and the Great Falls of the Missouri were stored in a cache to be picked up on the homeward journey. But tragically, when they returned the following





AMERICAN WHITE PELICAN, *PELECANUS ERYTHRORHYNCHOS;* JIM BRANDENBURG, MINDEN PICTURES



BIGHORN SHEEP, *OVIS CANADENSIS*

year, they found that water had seeped into the cache, destroying most of the specimens. This heartbreaking loss meant not only a failure of part of their mission—to record new flora—but also the ruin of months of hard work.

Still, Lewis returned with about 200 plant specimens gathered between Great Falls and the coast. Today most are at the Academy of Natural Sciences in Philadelphia.

Alfred "Ernie" Schuyler, associate curator of botany at the museum, spreads some on a table for me. They're kept in thin brown folders, like documents, their leaves and stems a brittle brown now, but they still carry an aura from the day they were snipped off a living plant.

"Lewis evidently just pressed specimens between loose sheets or in a book of some sort," says Ernie. "There'd have been one bundle in the process of being dried, which he'd have put beside the fire at night. Periodically he'd have removed specimens from that collection and added them to a finished bundle."

Dried specimens appear on the table before me: ragged robin, bitterroot, buffaloberry, Osage orange, Indian tobacco, bear grass, yellow bell, its dried bell nearly colorless now but still drooping gracefully.

"The botany of Lewis and Clark really has been a neglected area," says Ernie. "They discovered a lot of the plants you see today in wildflower guides. Drive through the northern Rockies and you have a pretty good chance of seeing 10 or 20 species that Lewis discovered. Very thorough."

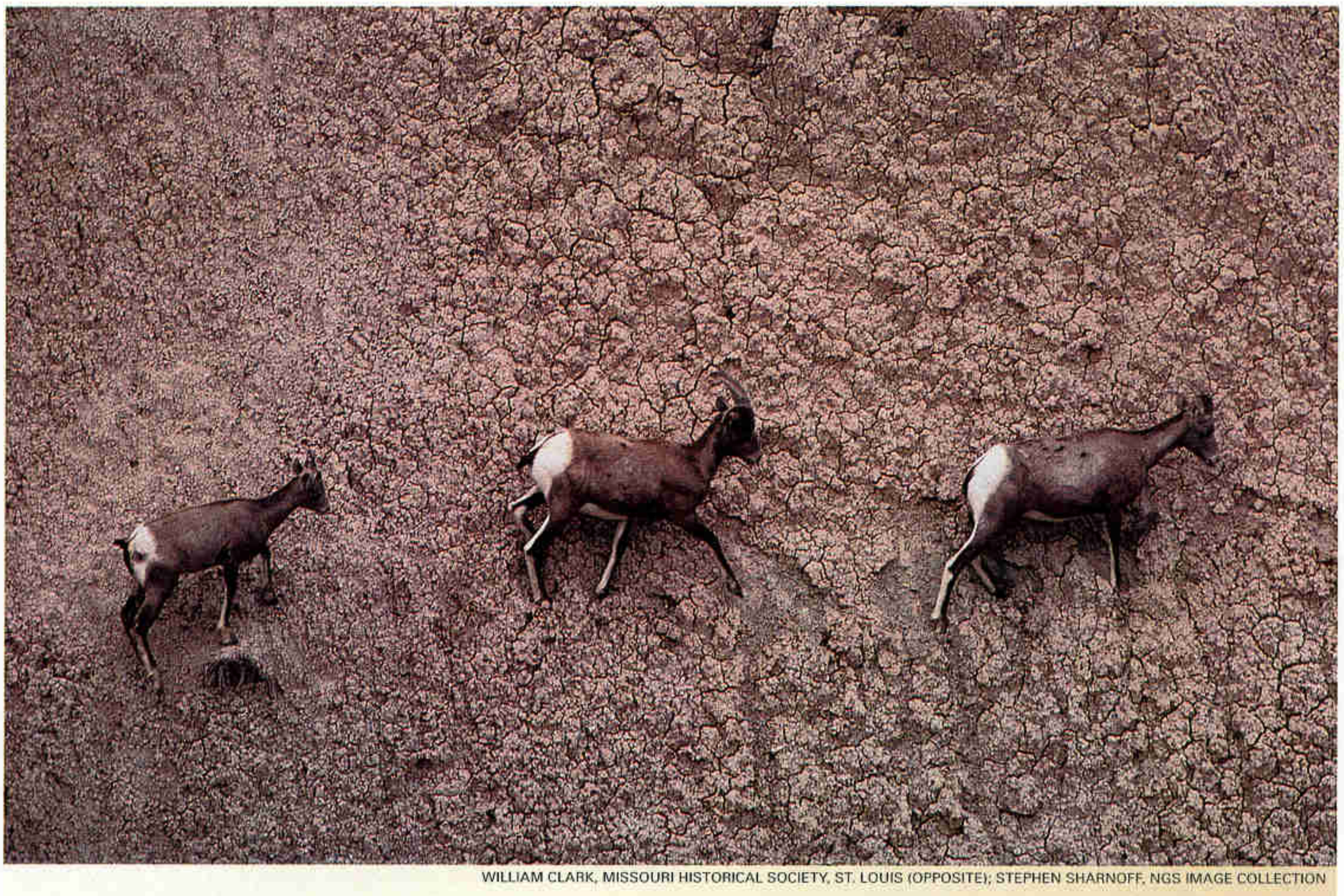
Of the trees Lewis and Clark recorded, none was more important to them than the broad-leaved cottonwood. The corps used cottonwood to make dugout canoes and a mast for their keelboat; during the portage around Great Falls they built wagons whose wheels were cross sections cut from cottonwoods; and time and again they camped under the welcoming shelter of the giant trees. When they came upon a grove, Lewis wrote that the trees "were quite reviving after the drairy country through which we had been passing."

One plant saved their lives while nearly killing them. During the grueling crossing of the Rockies food ran low, and the men almost starved. When they reached the prairies to the west of the mountains, Nez Perce Indians gave them food, including dried salmon and the steamed roots of the camas, a member of the lily family. Cooked, the roots had "a sweetish tast and much the consistency of a roasted onion," Lewis thought. Over the next few days the hungry men gorged themselves on this new diet, and nearly all became seriously ill with stomach cramps and diarrhea. Lewis blamed the camas, which "is pallateable but disagrees with me in every shape I have ever used it."

ON THEIR FINAL PUSH to the Pacific, Lewis and Clark ran into fewer new mammals and more birds and fish—including steelhead and the Columbian sharp-tailed grouse. Lewis, the careful observer, checked the grouse's feathers and noticed that "in the winter season this bird is booted even to the first joint of it's toes."

During the cold and rainy winter they spent in Fort Clatsop on the Oregon coast, Lewis made careful descriptions of some three dozen plants and a hundred animals, including 35 mammals, 50 birds, 10 reptiles and fish, and 5 invertebrates. He wrote thousands of words. He used, by one count, some 200 technical botanical terms—words like fusiform, peduncle, petiolate, carinated, and pericarp.

We shouldn't be surprised. Both Lewis and Clark—and Jefferson too—were men of their time, the age of Enlightenment. Amateur scientists everywhere were studying the natural world, and not just out of curiosity: New



WILLIAM CLARK, MISSOURI HISTORICAL SOCIETY, ST. LOUIS (OPPOSITE); STEPHEN SHARNOFF, NGS IMAGE COLLECTION

"With apparent unconcern," as Lewis wrote, bighorn sheep cross a cliff face in South Dakota. The explorers often saw the creatures—"a kind of Anamale with large Circuler horns"—in places where "had they made one false step the[y] must have been precipitated" at least 500 feet.

knowledge, they reasoned, should be put to practical use for the betterment of mankind. So Lewis and Clark continually quizzed the Indians about the uses to which they put various plants; they looked for mineral deposits; they mapped the heaviest concentrations of beaver for future trappers; they noted lands suitable for farming.

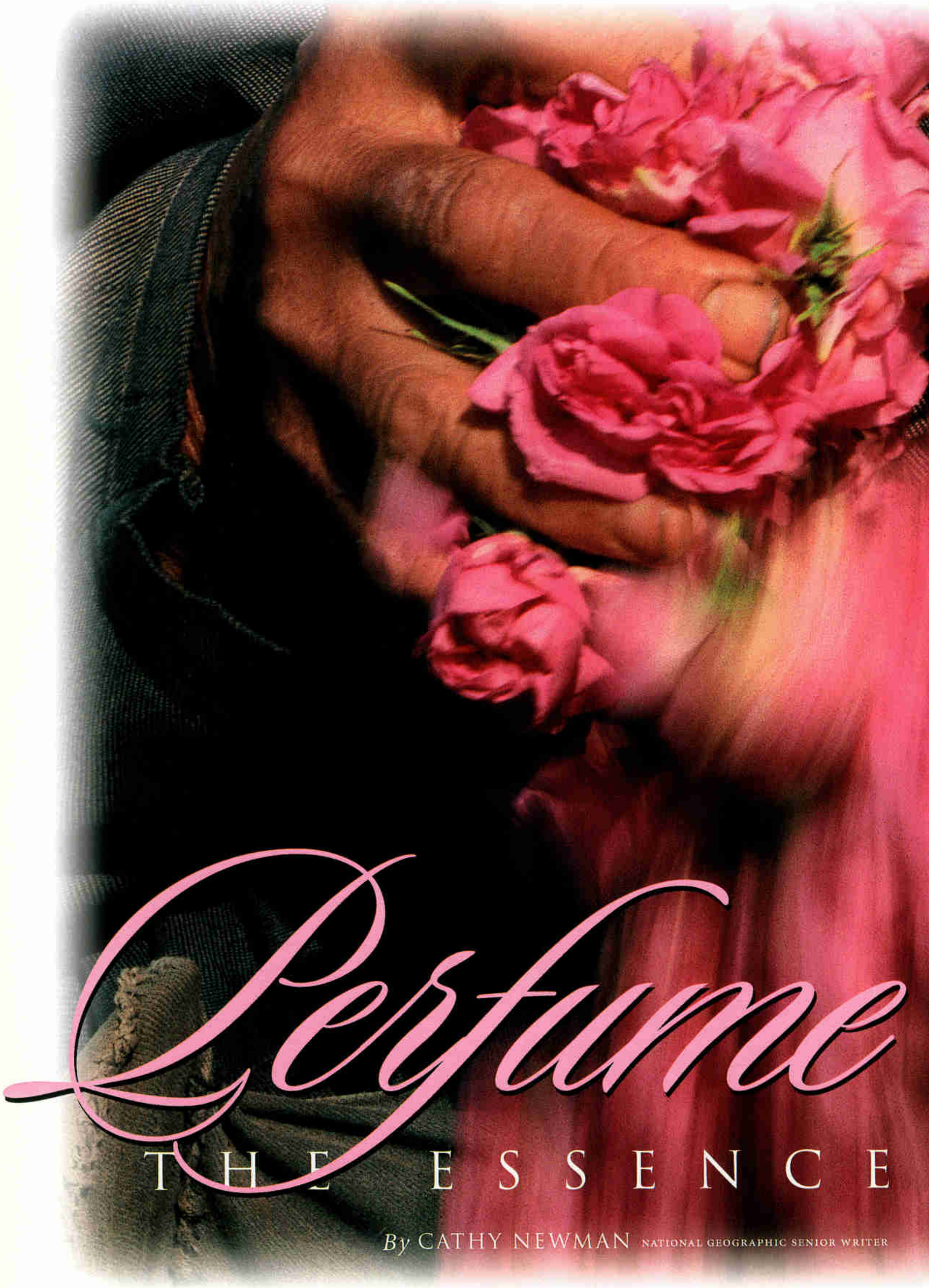
In the spring of 1806 the corps started for home. And on September 20 they spotted animals that thrilled them as much as any they had seen—domestic cows. It meant they were nearly home and "Caused a Shout to be raised for joy."

Well before they sent the prairie dog to Jefferson from Fort Mandan, they had sent cuttings from several plants, including Osage orange trees. Today there are trees at the University of Virginia in Charlottesville thought to be growing from those nearly 200-year-old cuttings. I see them with Jeff Ertel, the university's landscape superintendent, one chilly day in January. The most impressive grows near a house where visiting professors stay. "I love this old tree," says Jeff, touching its rough bark. "It has character."

It's gnarled and ancient, its trunk twisted around upon itself, blackened scars showing where limbs have been removed. A cardinal chirps in its uppermost branches, and ivy grows up its flank. Osage oranges the size of grapefruit lie scattered on the ground, many chewed by squirrels. "They sit on the ground and gnaw at the balls until they have them down to a size they can carry aloft," says Jeff. "They sit up there and eat them." On overhead branches little piles of nibblings show where they have perched.

The tree is scarred and bent but tough. It survives today alongside other less tangible legacies of the Corps of Discovery—competence and strength, discipline, enlightened curiosity, and the priceless capacity, when confronted with new wonders from the natural world, to be dazzled. □

Journey online with Lewis and Clark at *www.nationalgeographic.com/features/98/lewisclark.*



Perfume

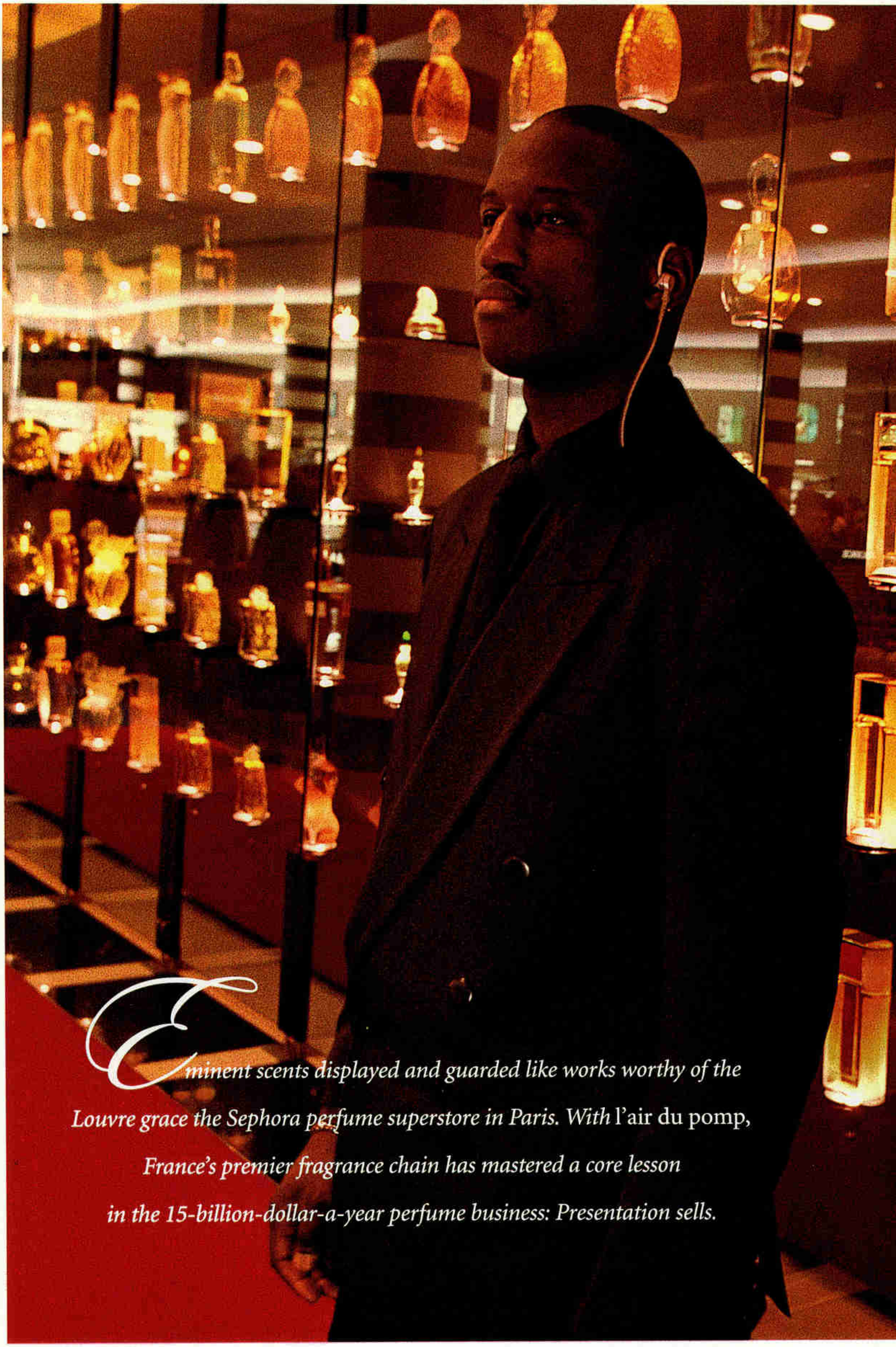
THE ESSENCE

By CATHY NEWMAN NATIONAL GEOGRAPHIC SENIOR WRITER

OF ILLUSION

Dew-kissed petals of damask roses spill from practiced fingers in Bulgaria's Valley of Roses. The traditional harvest—spanning some 350 years—yields oil prized in many fine fragrances. On the arduous road from petals to perfume, a global industry rides.

Photographs by ROBB KENDRICK



Eminent scents displayed and guarded like works worthy of the Louvre grace the Sephora perfume superstore in Paris. With l'air du pomp, *France's premier fragrance chain has mastered a core lesson in the 15-billion-dollar-a-year perfume business: Presentation sells.*



"Do you think of yourself as sensual or elegant?" Cathleen Montrose asks, pen poised over a yellow legal pad.

I'm in an office high above Madison Avenue in New York City. Cathleen, vice president of creative development for Firmenich, a company that creates scents for houses like Calvin Klein and Estée Lauder, is about to shepherd me through the process of fragrance creation.

"Elegant," I say, glancing down at a run in my stocking.

"What colors do you wear?"

"Black," I reply.

"And?"

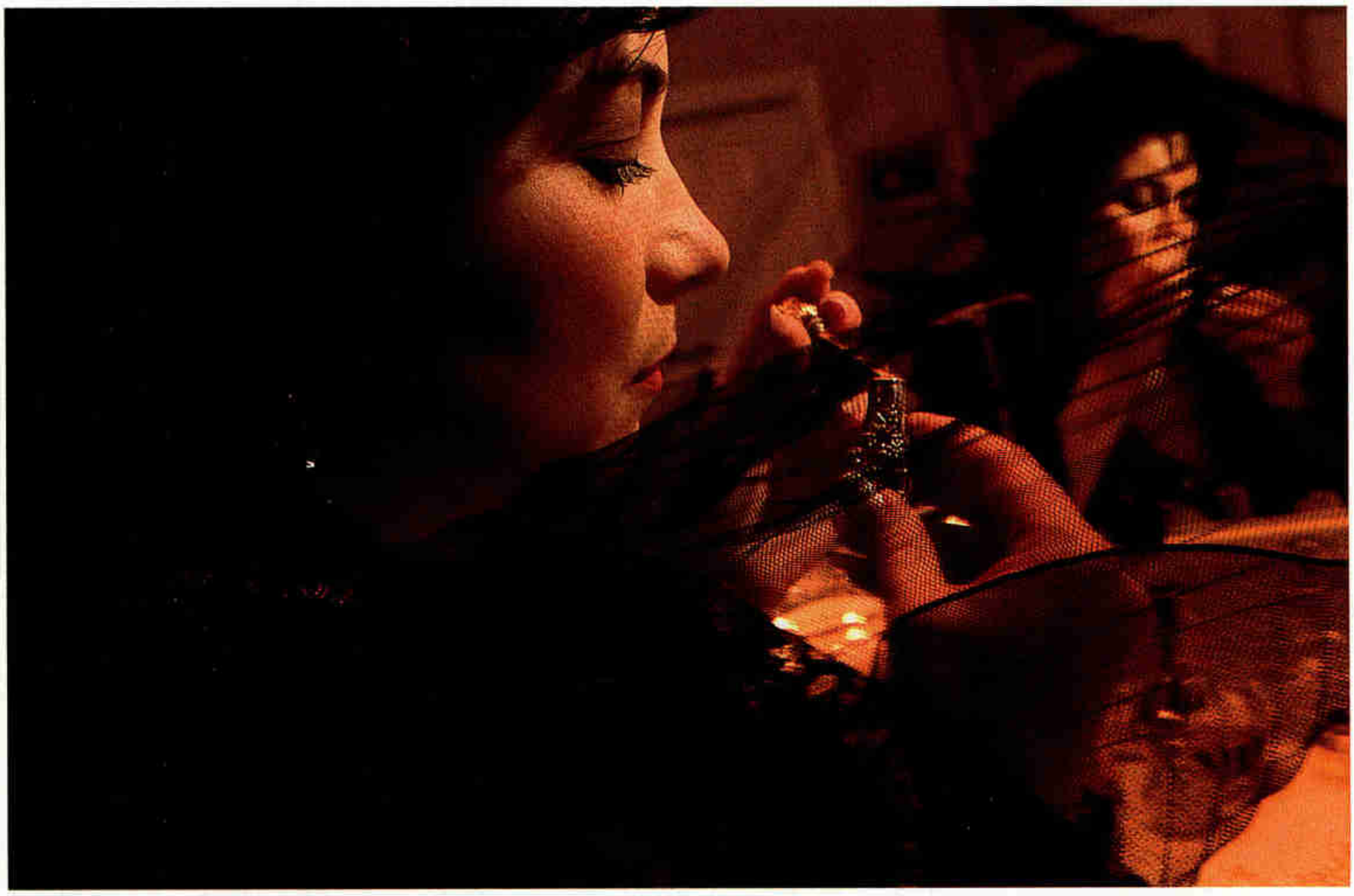
"Off-black."

"And?"

"Navy."

A hard look.

Suddenly, I'm babbling. "I'd rather sit with a book than attend a party. If I could afford them, I'd buy emeralds, not diamonds. I prefer ocean to mountains and can't stand suffocating florals."



"NO TUBEROSE," Montrose scribbles.

"Given my choice, I'd wear Yves St. Laurent, not that fussy Christian Lacroix (noting chewed fingernails); I prefer red wine to white (inspecting ink stain on hand), and I love John Singer Sargent portraits."

I take a deep breath. "I'd like an understated perfume. Sparkling. Sophisticated. Witty."

ROBB KENDRICK has been contributing photographs to the magazine since 1992. He lives on the Bad Dog Ranch in the Texas Hill Country.

The confession will be distilled into what's known as a brief—an outline of the perfume's concept and target customer (Generation X, ladies who lunch, or, in this case, me). The brief ("A fragrance that does not shout. Elegant, crisp, sophisticated," it reads) will be handed to five perfumers, each of whom will create a "Cathy" perfume. I will be expected to choose my favorite. If I were a big company like Christian Dior Perfumes, the process would be much the same, except that other suppliers such as Givaudan Roure, International Flavors & Fragrances (IFF), and Quest International would compete to create my perfume.

I'm invited to return in two weeks for the first round of submissions. I leave, and on the way to my next interview a lightbulb clicks on.

I've created a fantasy of myself.

Emeralds, red wine, Yves St. Laurent. *Right.* I grew up on Miami Beach, Florida, where a fashion statement was a clear plastic handbag trimmed with seashells and the nearest thing to wine on the table was seltzer water. I've been seduced by a never-to-be image. I've heard the siren song of glamour.

"Perfume," says Sophia Grojsman, IFF's star perfumer, "is a promise in a bottle."

We want to believe. We crave to be prettier, richer, sexier, happier than we are. "Aspirational" the industry calls it. Perfume speaks more to our vulnerabilities than our strengths. Consider the labels on the fragrances we buy: Joy, Dolce Vita, Pleasures, White Diamonds, Beautiful.

Said Charles Revson, the cosmetics czar who in 1973 created Charlie, the first American-lifestyle perfume: "We sell hope."

And we buy. Last year worldwide sales of fragrance topped 15 billion dollars, more than 6 billion dollars in the United States alone.

The silver-tongued industry that conjures these dreams is part circus, part creative magic, with smoke and mirrors galore. (Indeed the word perfume probably comes from the Provençal word *perfumar:* to spread smoke. The first perfumes were incense, an unfurling plume of hope directed at the gods.)

"It's an industry of myths," says Allan Mottus, a publisher and consultant. "It does not hold up under the scrutiny of daylight."

We sit in a coffee shop off Union Square in New York, as Mottus recounts stories of hit perfumes: "Giorgio was done on a wing and a prayer, a toll-free number, a magazine scent strip, and went off the charts." Flops: "If you've got a dog, you can't dress it up and take it to a dance." Arrogance: "Someone has a hit, then everyone else says, I can do that—it's a lot like show business," Mottus sighs.

Despite the hype, the allure of fragrance is real. The seductive power of perfume is as old as Cleopatra, who, not wanting to underplay her hand, received the Roman statesman Mark Antony on a barge with sails soaked in fragrance "so perfumed," Shakespeare tells us, "that the winds were lovesick with them."

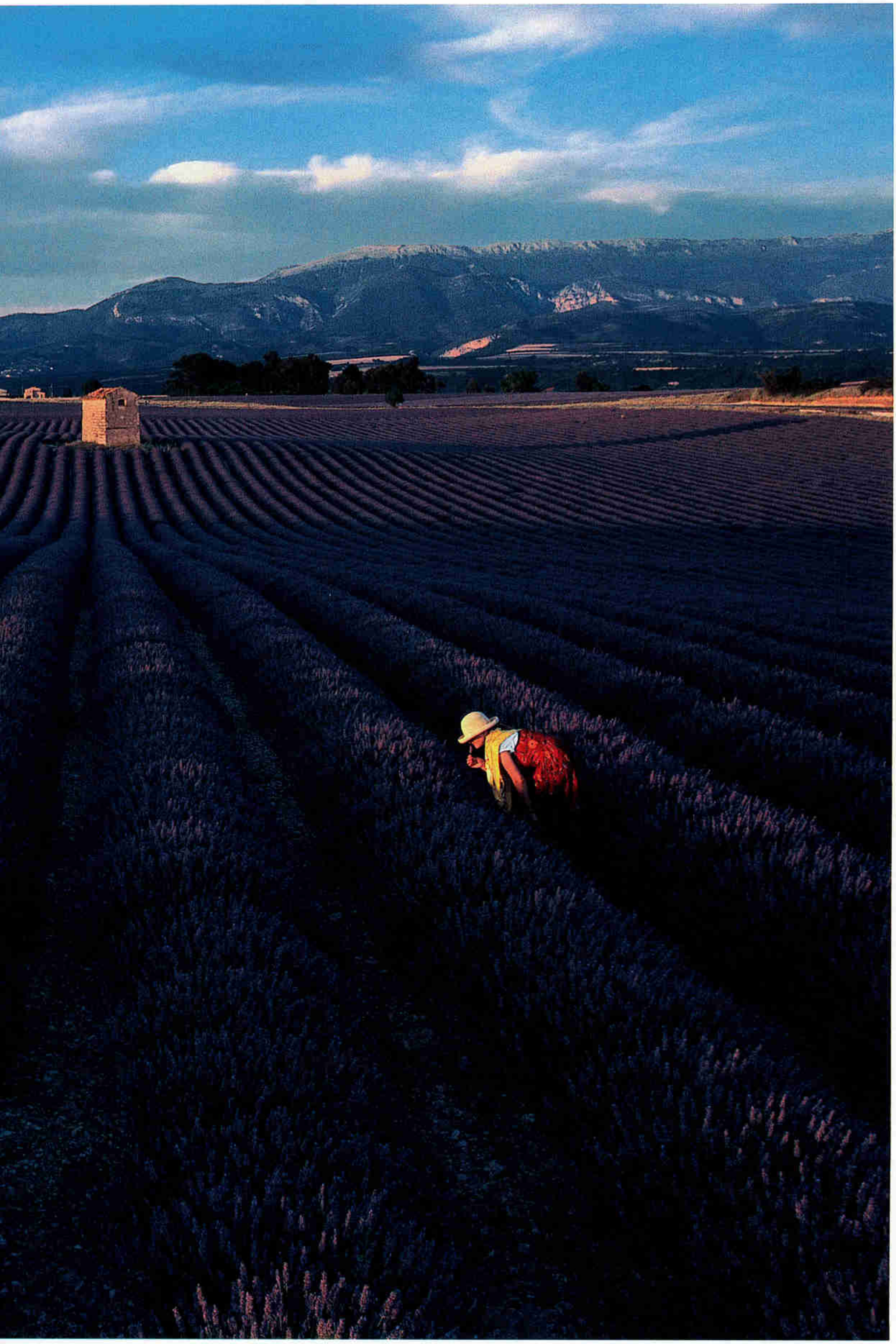
Assyrians perfumed their beards. Nero bathed in rose wine. In the 18th century scented woodwork decorated many a boudoir.

"While other spirits sail on symphonies / Mine, my beloved, swims along your scent," wrote the 19th-century poet Baudelaire.

For Baudelaire—and many of us—fragrance taps into deep wells of memory and desire. Sometimes, with vengeance. Consider the jilted girlfriend who, before her furious departure, poured an entire bottle of her perfume on her ex's sheets.

"For me perfume is an indulgence," says Angie Battaglia (opposite). The Austin, Texas, businesswoman owns nearly 30 scents, which she'll select depending on the season, her mood, or her dress. "Perfumes are an accessory, like jewelry. Some are conservative, others lively, like uncorking champagne." Manufacturers, who now offer about a thousand fragrances, scramble to attract today's fickle consumers.

Enchantment blooms in orderly rows on the Plateau de Valensole in Provence, where fragrant fields of lavandin, a lavender hybrid, lure passersby. Heart of traditional perfumery, France has lost much of its flower production to developing nations with less costly land and labor.



Memory and fragrance are intertwined, some biologists insist, because the sense of smell plugs smack into the limbic system, the seat of emotion in the brain. No other sense has such immediate access.

My mother wore L'Heure Bleue. To unstopper that dusky scent returns me to my child self, tucked into bed. Late at night, after being out, she would come into my room to kiss me, enveloping me in a cloud of powdery warmth.

For Thierry Wasser, a perfumer at Firmenich, the scent of Chanel's Cuir de Russie conjures his father.

"My father always wore driving gloves," Wasser says, toying with a bottle of fragrance in front of him. "He would splash on his fragrance, pull on his gloves, and drive off. He left for good when I was three. He died when I was 15. He pulled off the road in the south of France and slumped over the wheel. A heart attack.

"At 18 I learned to drive. I took out his gloves. When I put them on, the warmth of my hands released the scent of his cologne."

Wasser and I stare at each other in silence for a moment. He dips a blotter into the bottle of Cuir de Russie and waves it under my nose.

"The ghost in the bottle," he says.

Keeper of civet cats, Ethiopian farmer Aba Bulgu Dina is at the tail end of a lucrative tradition. Civet, a buttery secretion scraped from the cat's perineal glands, has long been prized as a fixative in perfumes. Because of animal-welfare and conservation concerns, synthetics are now usually substituted for animal elements and can also replicate scents from plants in decline, such as sandalwood, felled in India (below) and distilled for its sensuous oil.

IN THE CALIBRATED WORLD of chemistry, a fragrance is a mix of oils in a 75 to 95 percent alcohol solution. Perfume has a concentration of oils greater than 22 percent. Eau de parfum has a 15 to 22 percent concentration. The less heady eau de toilette, 8 to 15 percent. The even more dilute cologne contains less than 5 percent oils.

The heart of a fragrance lies in the fraction of oils that evaporates off skin, hits the sensors in the lining of the nose, shoots up the olfactory bulb, and plucks a chord of delight in the mind. The traditional elements come from animals—musk (now replaced mostly by synthetics) from a deer, for example—and plants, most notably flowers.

In May, the season of roses, I visit Grasse, France. Surely the most celestial of roses is the *rose de mai*—the rose of May. The soil of Provence, mild weather, and blooms of *Rosa centifolia*, as it is known to botanists, conspire to produce an oil of exquisite delicacy.



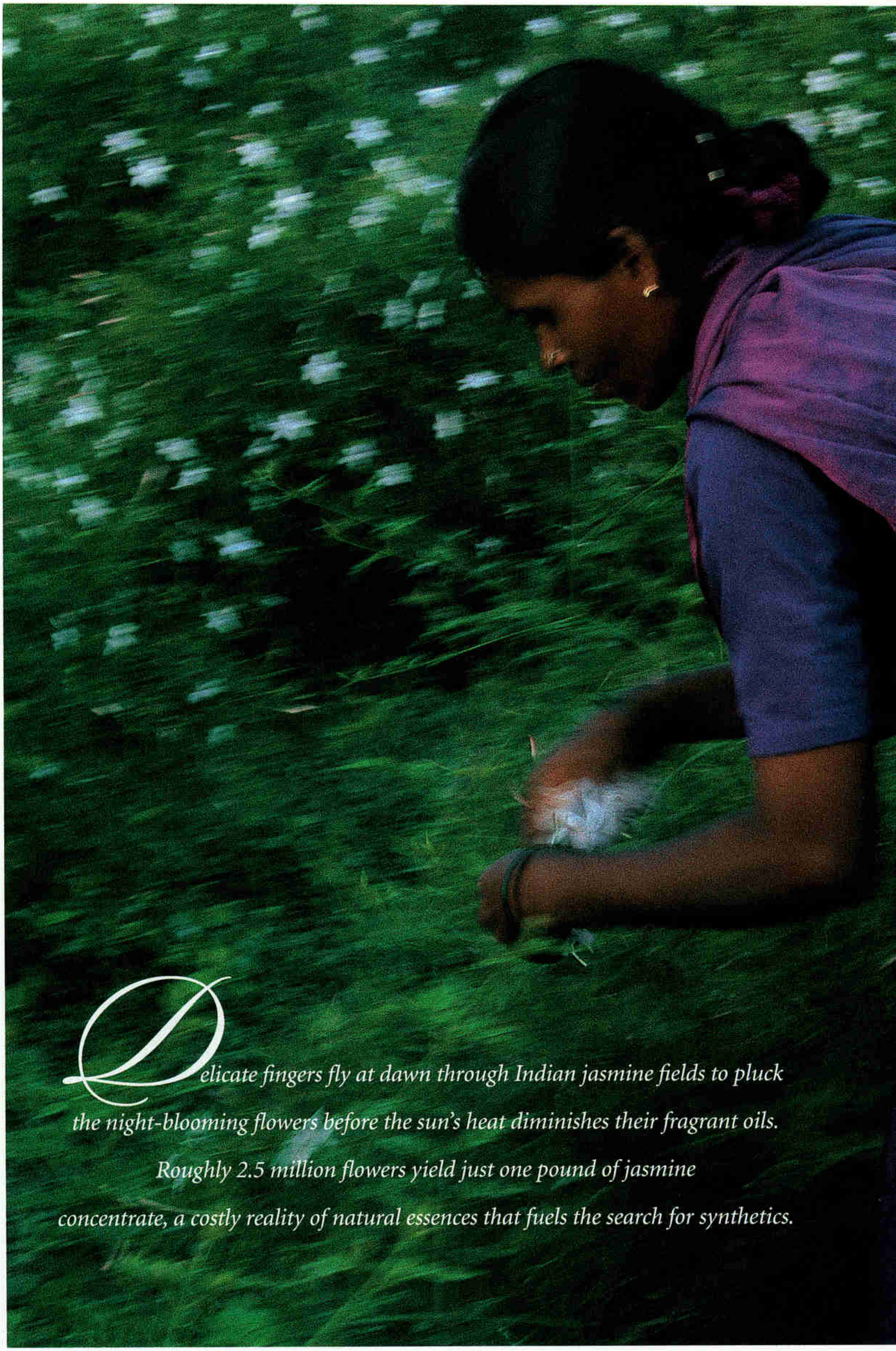
"Like fine wine," says Joseph Mul, owner of 12 acres of rose fields near Grasse, snuggled in a valley between the French Alps and Mediterranean Sea.

Mul, a large round man with a beaming, equally rotund face, shows me his fields, where women are harvesting flowers. "The roses are picked as soon as they are ready," he says. "Not a second before or after."

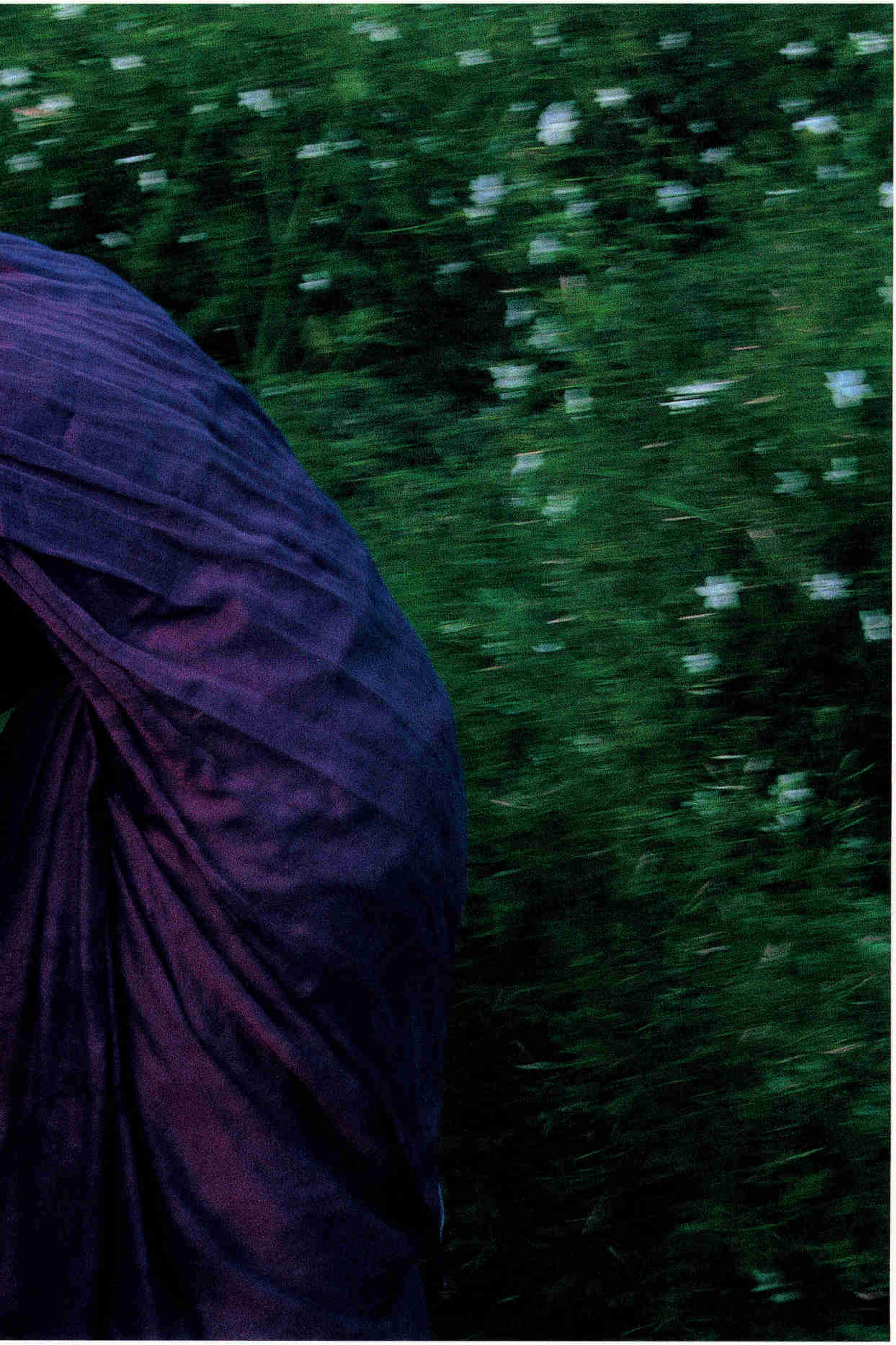
He plucks a rose from a candelabra of branches. "Just opened," he says with a smile of satisfaction and hands me a pale pink bud. I tuck it in a buttonhole. "It takes 800 pounds of roses to produce a pound of concentrate. Unfortunately, this isn't a good year. Only six to seven blooms per branch. Sometimes we have as many as 25."

Why? I ask.





Delicate fingers fly at dawn through Indian jasmine fields to pluck the night-blooming flowers before the sun's heat diminishes their fragrant oils. Roughly 2.5 million flowers yield just one pound of jasmine concentrate, a costly reality of natural essences that fuels the search for synthetics.





"Weather. Spring was cold, and it hardly rained, which slowed growth. The harvest will be 20 percent less." He looks mournful.

It is ten o'clock. The sun has begun to wilt the flowers, marking the end of that day's harvest. "Picking roses will never be done by machine," says Mul. "Labor is 60 percent of the cost and makes the difference between the price of rose in Grasse and in Morocco. What I pay for a day's work here is worth a month's work there."

Just then, a gust of wind lifts the rose from my buttonhole onto the ground. Mul picks it up and flicks it into a burlap bag.

"I never waste a single petal," he says.



On scent safari for supplier Givaudan Roure, botanist Scott Mori (left) probes a treetop bloom in French Guiana. An elusive new smell, like that from a rain forest orchid, can be collected in a greenhouse with devices like a glass fiber coated with an absorbent, used by Braja Mookherjee (above) at International Flavors & Fragrances (IFF). The essence can then be chemically analyzed and synthetically re-created. Capturing scent, says Mookherjee, "is a divine business."

FLORAL ECONOMICS: The price of Joseph Mul's rose de mai absolute is $3,650 a pound. Price of Moroccan rose oil is $600. Once Provence was the source of rose, jasmine, lavender, and many wonderful essential oils. Today most raw materials come from developing countries. Land in Provence has become too costly for flowers. Condominiums and vacation homes sprout where roses once grew. High labor costs add to the burden. So the business has shifted to countries like Bulgaria, Turkey, Morocco.

So, too, jasmine. In 1975 nearly 412 pounds of jasmine absolute was produced in the Grasse region. By 1996 this had dropped to about 60 pounds (at $12,000 a pound). Companies are switching to less costly (and less subtle) jasmine from elsewhere. Probably only three perfume houses today use French jasmine—Chanel, Guerlain, and Jean Patou. Cultivation of jasmine moved to Egypt, Morocco, and India for the same reasons roses moved.

Only one large field of jasmine remains in Provence. It, too, belongs to Joseph Mul, and its survival is not guaranteed.

"You must come back in September for the jasmine," says Françoise Marin, director of the School of Perfumery run by Givaudan Roure in Grasse. She hands me a blotter dipped in jasmine absolute. It is rich, lush, the evocation of tropical nights heavy with the scent of flowers.

She spoke of herself as a child of six, jumping in jasmine up to her waist. "Like landing in feathers," she says. "And the scent. . . ." A silence as the memory is conjured. "I cannot describe. The flowers themselves. Softer than silk. So fragile. You hold a bloom in your hand, and in a few minutes it turns brown."

The next day we drive by the Saint-Donat Country Club, where manicured greens have replaced the jasmine fields. "You'd think they could at least call it the Jasmine Country Club!" Françoise remarks. Then past the tiny town of Plascassier, engulfed by bedroom communities for Cannes and Nice. "Rose fields once. And now. . . ." A puff of air between pursed lips.

"You must come back for the jasmine," she repeats. "There is one field left. One only. In five, ten years it will be gone."

If it is, blame the dismal science of economics, for the exquisite scent of French jasmine will have vanished from the world of perfume.



LET US DISTILL THIS TRADE in essential oils down to the sound of the phone ringing in Dominique Goby's office in Grasse. His phone is almost always ringing. It may be a Japanese client asking about the price of patchouli, an herb ("it will fall"), or a German client asking for a sample of lavender ("on the way").

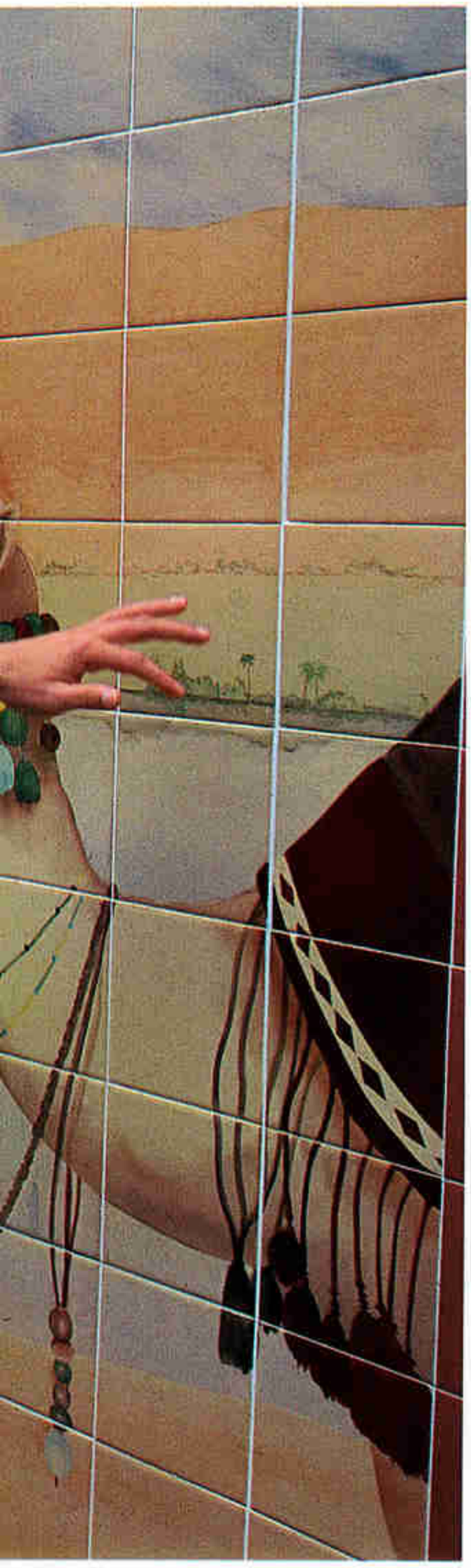
As sales and marketing director for Systems Bio-Industrie, a seller of perfumery oils, Goby watches some 60 different materials rise and fall in price. "Right now I'm setting up my campaign for rose oil," he says. "This year the price of roses in Morocco increased 20 percent. A short crop. I may have to set quotas for our clients."

His worries are weather: "A typhoon in Réunion may ruin the geranium crop." And politics: "Take galbanum, a gum from a plant growing in Iran. When the ayatollah came into power, the market collapsed."

Sometimes a small shortage translates into sheer speculative fever. "In November patchouli oil was $10 a pound. By April it had climbed to $30 a pound." He showed me a chart that looked like an EKG. "Of course, it will drop again. Probably by June. I tell clients: Wait if you can."

But the business of perfumery can't afford to wait out the vagaries of politics, weather, and speculative fever. Thanks to synthetic materials, it

When Nigel Brailey, at right, awakes on a Wednesday, he smells the aroma of lemon—and knows that swimming at the local pool is on tap for the day. Andlaw House, a therapeutic facility in Exeter, England, circulates a different fragrance for each day of the week as one of several sensory cues



to help impaired residents like Nigel, who is deaf and blind, navigate the day. Signing, familiar objects, and helping hands also reinforce the routine.

"Being able to anticipate what's coming next is almost a basic human right," says education manager John Shaw.

doesn't have to. In the 1930s, says Geoffrey Webster, president of fragrances worldwide at Givaudan Roure, a perfume might be 85 percent natural, 15 percent chemical. Today it's the opposite. Before 1890 perfumes were totally natural: simple floral waters with names like Coeur de Rose. "Figurative perfumes," Yves de Chiris of Quest calls them. "The advent of synthetics allowed impressionism in perfumes," he says. Instead of a photograph of water lilies, think of a Monet painting.

Synthetics also allow the replication of scents that do not extract well, such as lilac. They allow the use of scents from flowers too rare to be picked, or products like musk that involve the killing of a wild animal. "Good fragrance is a balance between naturals and synthetics," says perfumer Harry Frémont. "Naturals give richness and roundness; synthetics, backbone and sparkle."

To make a perfume, take four or five or hundreds of ingredients, known as notes, and add one perfumer. First of all: notes. The world of perfumery uses about 2,000 notes, but many are simply variations on a theme. There are light, sparkling citrus notes like lemon or bergamot. Dark, resiny notes like balsam or olibanum (frankincense). Fragrant, woody notes like sandalwood or cedar. Bracing, herbal ones like lavender or basil.

There may be 20 rose notes to consider. Do you want Bulgarian, Moroccan, Turkish, or French rose? A rose synthetic like rhodinol, perhaps? "Choosing a note is like picking a color, say blue, then picking a shade in that color," says Steve DeMercado, a perfumer with Givaudan Roure.

The perfumer acts as composer. The arrangement of a perfume is not unlike a three-part fugue. The part of a perfume known as the top note, or head, spins off the skin immediately; it's a fanfare and vanishes in minutes. The middle note, or heart—compounded of heavier materials that last for hours—sets the theme. The base note, or dry down, gives depth and, like a resonating chord, can persist for a day or two.

"You dream your perfume before you write the formula," Jean Kerleo says. Kerleo, a courtly, graying man, is chief perfumer for Jean Patou. "You begin as a composer. You finish as a sculptor."

"And you have to be crazy in a way," adds Sophia Grojsman. On the day I visit her in New York City at IFF, Grojsman wears a black-leather skirt bisected by a huge metal zipper, tottery black high heels, and black stockings. As IFF's star perfumer, she has blockbusters like Eternity, Trésor, and Paris to her credit.

An assistant walks in. "He wants wild meadow number four, five, six," she says. Translation: An evaluator wants to see three new versions of a scent in progress. *Right now.*

"I don't believe it," Sophia says, hand on forehead. "Insanity. . . ."

She leans forward conspiratorially. "I am going to close the door and do something illegal. I am going to light a cigarette."

But doesn't the smoke affect . . . ?

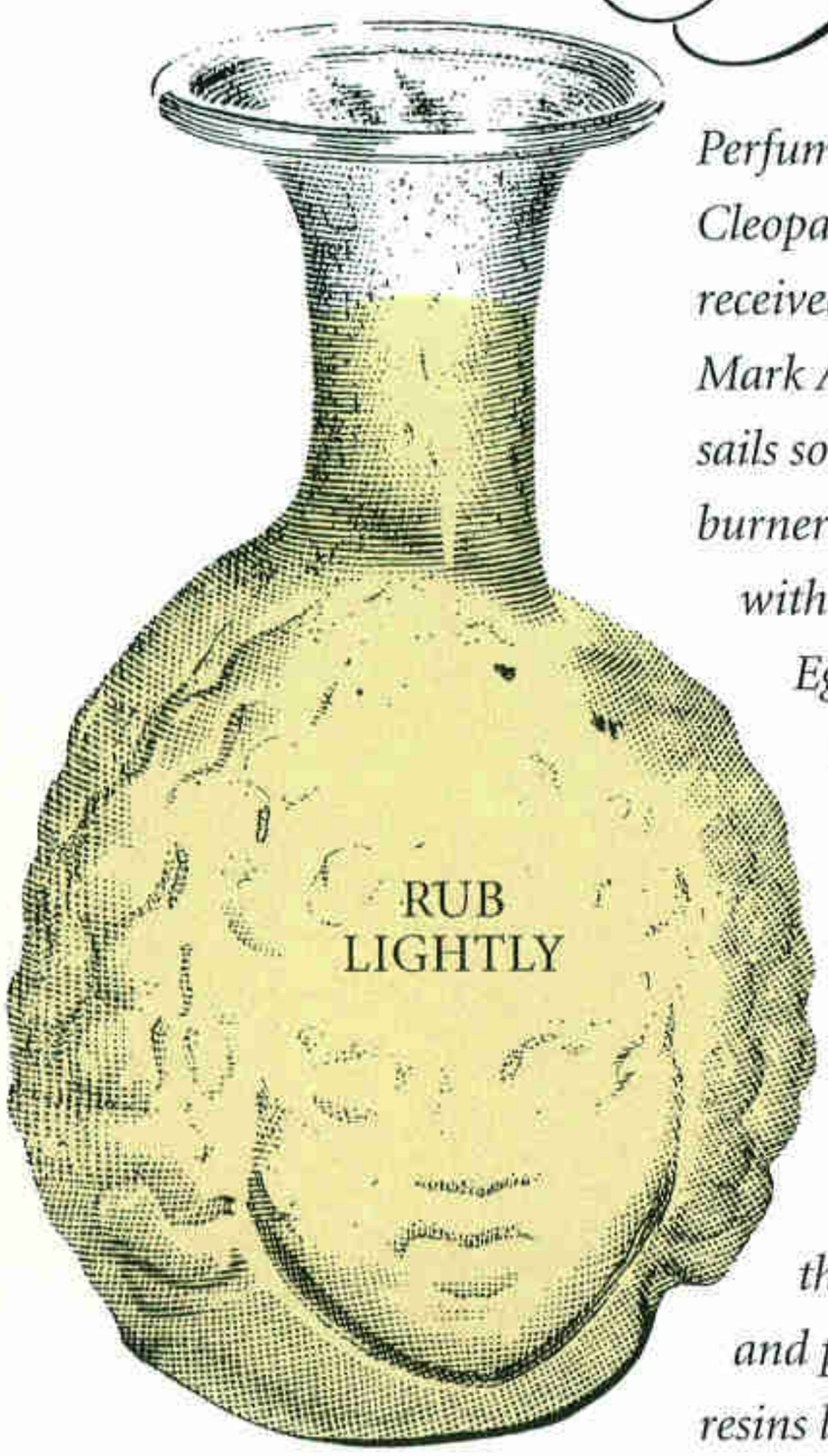
"I bypass it," she says, brushing off the question as if it were a stray ash. "I go right to the heart of a fragrance. Some people smell top notes first. I go deeper. I search for the *soul*."

An assistant scurries in with two blotters. Sophia waves one, then the other, briefly beneath her nose. A pause.

"I like the new one better."

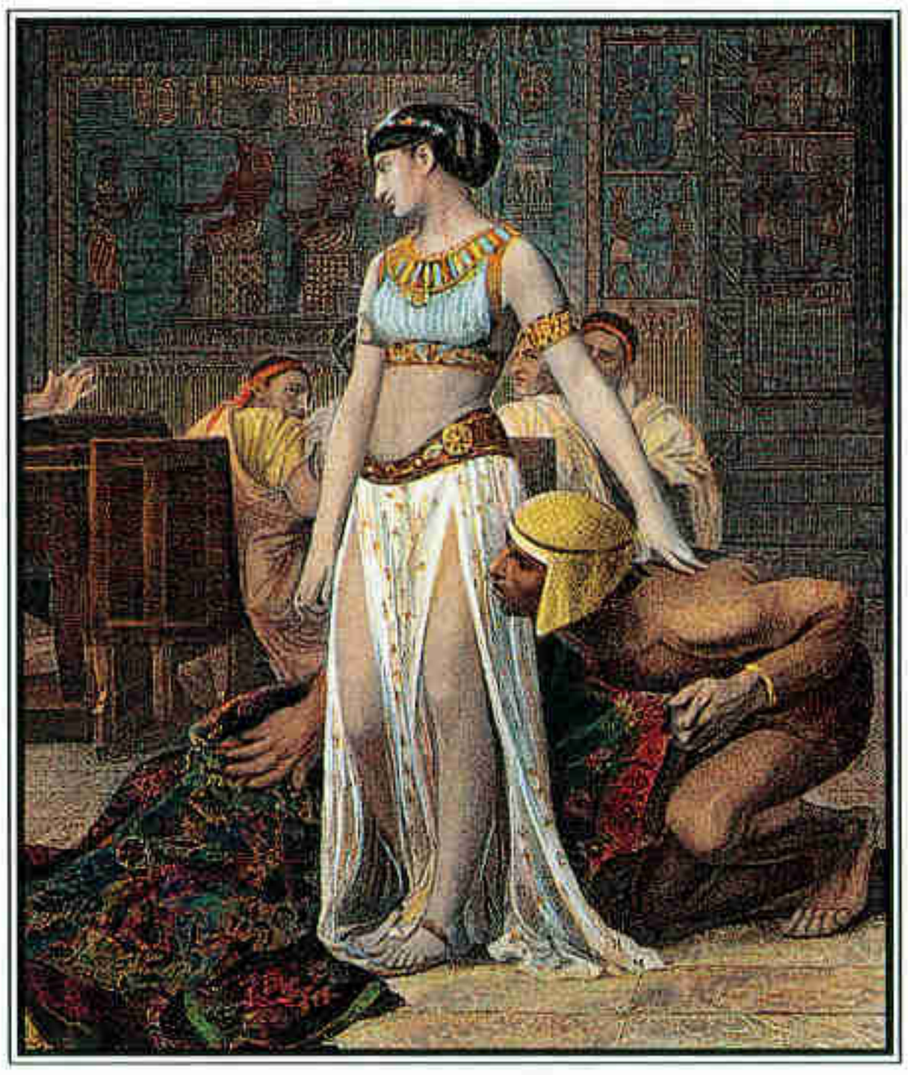
The assistant looks relieved.

Perfumes of Cleopatra



To smell the historical fragrances on these two pages, use your finger to swipe—do not scratch—the colored part of the bottles. Friction and heat from your hand will release the perfume oils, which were encapsulated in a special polymer to form droplets five to seven microns in diameter—about a tenth as wide as a human hair. The encapsulated droplets of perfume oil were then mixed with a lacquer and printed on the page.

CLEOPATRA: DETAIL FROM AN ENGRAVING OF A PAINTING BY LÉON GERÔME; NAPOLEON: PAINTING BY JACQUES-LOUIS DAVID. BOTH IMAGES FROM THE GRANGER COLLECTION, NEW YORK CITY. ART BY WILLIAM H. BOND



Perfume is pure seduction. Cleopatra, Queen of the Nile, received the Roman statesman Mark Antony on a barge with sails soaked in perfume. Incense burners surrounded her throne with an intoxicating cloud. The Egyptian queen likely wore something similar to the unguent in the Roman flask at left. The scent was reconstructed from ancient formulas by the late Giuseppe Donato, a chemist associated with the Institute of Cultural Resources of the National Research Council of Italy, and perfumer Giulio Arippa of Chimifar in Genoa. Its ingredients are costly resins like balsam and myrrh, spices like cinnamon and cardamom, and iris root, lotus, saffron, and marjoram. Women in ancient Rome were massaged after the bath by slaves who used a different fragrance for each part of the body, and people perfumed their hair, their garments, even the soles of their feet.

"I live with these fragrances days, months," Sophia continues. "I put them on in the middle of the night. My husband will say: Can I smell? But the public is what I count on. Taxi drivers are the best. Once I was working on something very sexy, very spiritual; I get into a cab wearing it, and the guy's like: 'I can't drive. I can't drive.'

"I build my fragrances from bottom to top. Like a pyramid. In layers. It's geometric. The art closest to what I do is music."

"Compare your perfumes to an opera," I ask. "Which would it be?"

A deep laugh. "*Carmen.* I want every woman to be mysterious and ardent. I have this urge to be alive. To be somebody. I'm a Gypsy by nature. I *am* Carmen."

I RETURN TO FIRMENICH to check on my project, the Cathy perfume. Cathleen Montrose hands me a box with eight different small bottles of perfume. My impulse: Spray them all on at once, but Cathleen says, no, wear one each day, and keep a perfume diary.

The perfumers offer advice. Annie Buzantian explains that you really can't get an idea whether a perfume works or not until you wear it. "Like the difference between a dress on the hanger and a dress on your body." Harry Frémont says the first impression is often the right one. "You can overthink a perfume," he tells me.

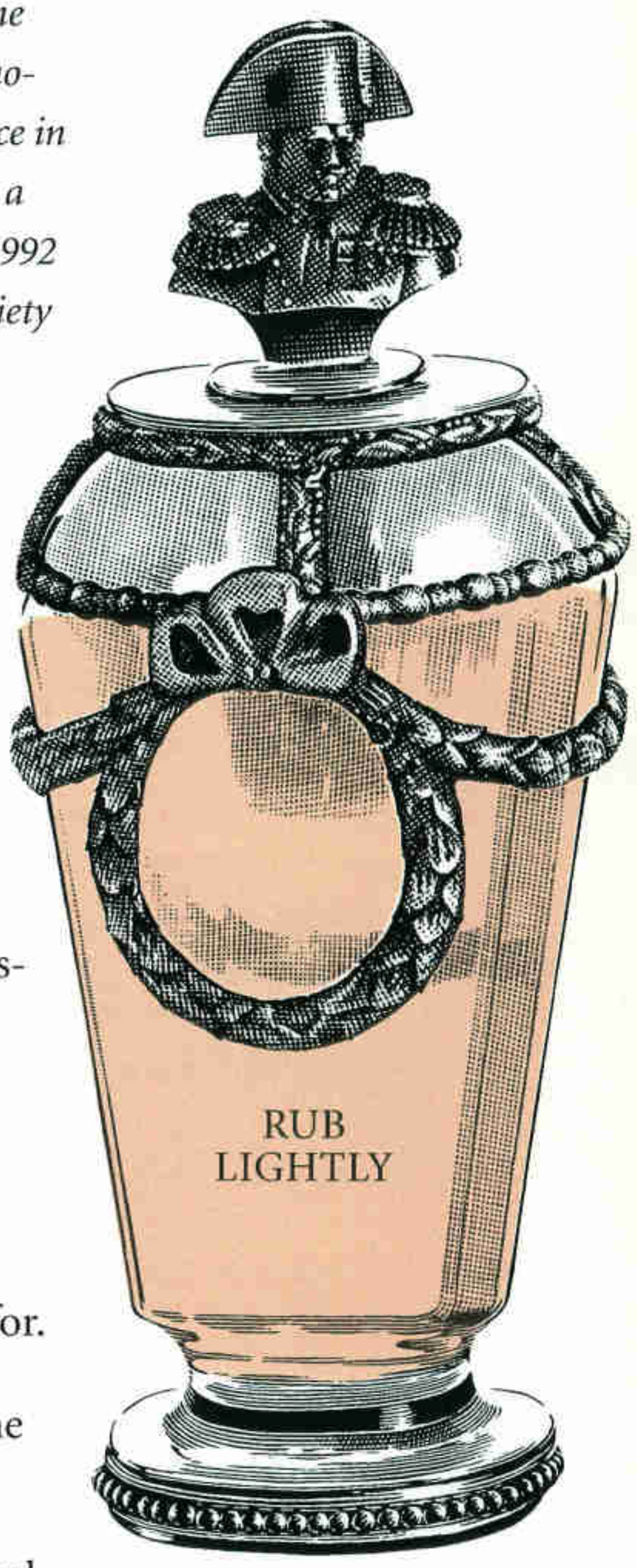
Each day I wear one fragrance. At night I record my impressions. *Too heady. Too romantic. I feel like an imposter,* I write of the one labeled Mirage, a submission so elegant it makes me feel hopelessly awkward. *As soothing as a cashmere shawl, but too sweet,* I note of Wraparound.

and Napoleon

SAMPLE THESE SCENTS

Napoleon loved cologne. A flask of scent tucked into his boot masked the stench of war. He used a bottle or two each day and placed an order shortly before his defeat at Waterloo in 1815. But in exile on St. Helena in the South Atlantic his life as emperor of France dwindled to a memory. Memories, at least, can be retrieved. His valet on St. Helena, Ali, procured a formula for Napoleon's cologne and compounded the scent from ingredients like lemon and rosemary that grew on the island. That fragrance appears in this crystal bottle topped by a stopper with Napoleon's bust. Years later Ali's belongings were auctioned. The formula for the scent was brought to the Osmothèque, a museum of fragrance in Versailles, by André Damien, a former mayor of the city. In 1992 Jean Kerleo of the French Society of Perfumers was asked to remake it. After a month of trials he held Napoleon's cologne. "It was a very moving moment," he says.





Exotic, hypnotic, like a walk through a suq, I say of the irresistibly named Metaphor. *But, too weak.*

I mail my comments, embarrassed by my fussiness. Does my fickleness offend the perfumers? Of course not, Cathleen assures me, when we talk. Their job is to please the client.

The battle to hook the customer culminates at the counter. "A customer must fall into a fragrance immediately," says Yves de Chiris. "Any hesitation and you lose."

I visit Sephora in Paris. A store of polished granite, chrome, and glass. Retailing as theater—an electronic ticker tape flashes the price of Chanel No. 5 or cK One in New York, Buenos Aires, and London. Salespeople wear head-to-toe black. Even the pens they hand you to sign your sales slip are black and sleek. It's all so chic. So hip. To die for.

Hundreds of fragrances sit on shelves, a fraction of the thousand or so brands on the market. With more—many more—to come. The industry is in a hamster-wheel bind. A hundred new perfumes were launched in the United States last year. In France, even more.

"It's a 'what's new?' business," says Ann Gottlieb, a New York consultant, who has shepherded about a billion dollars' worth of fragrances through the process of creation. "I call them the BIC fragrances. It's the disposable era. This is a generation with a short attention span." The trend is hit fast, hit big, move on. Two decades ago scents took one, two, three years to develop. Now, they're done in months.

And they drop like flies. Of ten launches, maybe two will break even, seven will fold, one might succeed. An expensive gamble:

It can cost 20 million dollars to introduce a new scent.

Why bother? For the money, of course. Big money. Take Klein's cK One—250 million dollars' worth shipped its first year out—or a classic like Chanel No. 5, which according to consultant Allan Mottus has rung up more than a billion dollars in sales over 75 years.

Spectacular ups; spectacular downs.

One corpse left by the wayside was the 40 million dollars reportedly lost on Christian Lacroix's C'est la Vie in 1989. Other sinking ships: perfumes by Cher, Sophia Loren, and Pelé. Even Kermit the Frog put his webbed imprimatur on a fragrance: Amphibia, a scent with "green" notes. It lasted a year.

Then there was Armani's Giò: a multimillion-dollar fizzle.

What went wrong?

It certainly wasn't the launch party. *Tout* New York and Hollywood showed up. Guests crowded a Manhattan office basement reconstituted as a Moroccan palace. They ate off Moroccan brass dinnerware under 10,000 square feet of muslin tent. They sipped mint tea and champagne in the shade of palm trees. Cost: about a million dollars.

"As much as we try to be analytic, study trends, and market test, at the end of the day it's a crapshoot," says one marketing director.

Does the world *really* need a new fragrance?

"Yes," says Patrick Firmenich, vice president of Firmenich. "The world needs a new fragrance the way it needs a new sculpture or painting."

"Certainly not," says Vèra Strübi, president of Thierry Mugler Perfumes. "Unless it can be creative and different."

BOB ALIANO is hoping that PF1 (Prestige Fragrance number one) will be creative and different.

"It's the battle of the Titans," he tells me. A big man with a shiny helmet of black hair and toothbrush mustache, Aliano, vice president of creative perfumery for Giorgio Beverly Hills, explains that project PF1 has come down to a runoff between Firmenich and IFF. Suppliers like IFF and Firmenich may spend a quarter of a million dollars to create a fragrance like PF1 on spec, with no guarantee they'll win the contract to supply the "juice," as the scent is known. It's win or lose. There is no second place.

"When you lose a competition for a fragrance, do you say, 'It's just a perfume'?" I ask Thierry Wasser, the perfumer at Firmenich. He frowns.

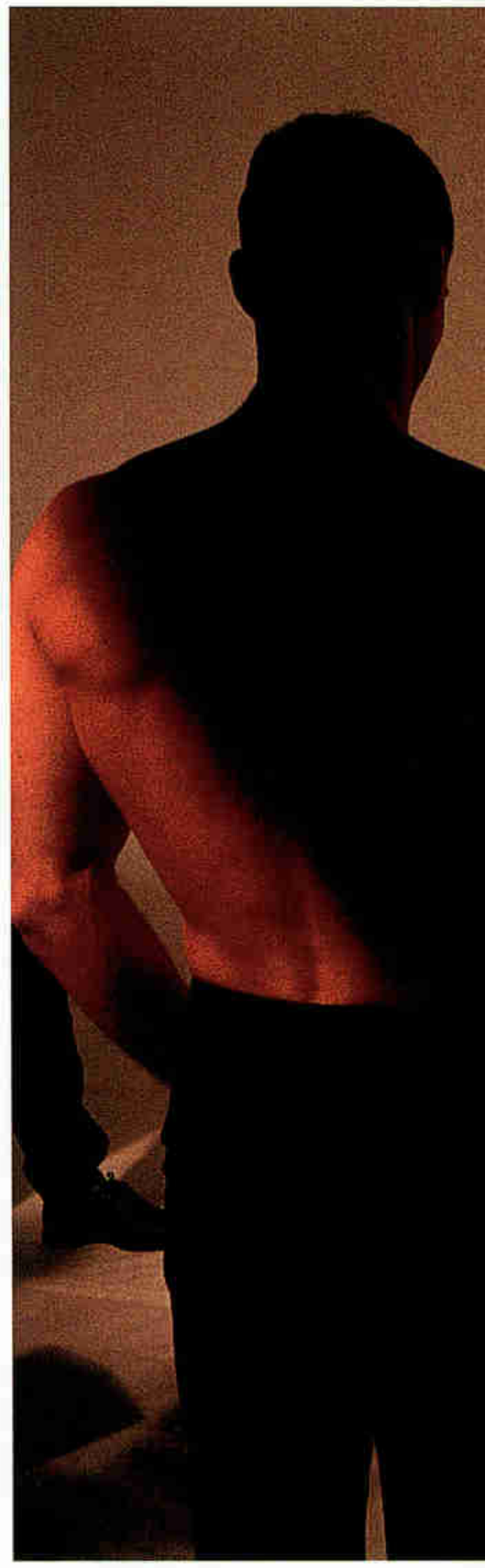
"Just a perfume. Just a perfume. That's my hope, my life, my self in that bottle. It's why we're here from seven in the morning to seven at night. *Just a perfume!* When you lose a competition, you kill hope. And when you open the bottle, a bit of us flies out."

IFF, where I am now, is gambling on a submission based on an orchid note. The scent of the orchid, a rare golden bloom that grows in tropical Asia, has been re-created in the lab. Across town, Firmenich is banking on a scent built on a merlot wine note.

Aliano explains the concept: "A perfume so beautiful men will miss you when you leave the room. To sell for $300 an ounce. Maybe more. The sky's the limit!"

Braja Mookherjee, IFF's vice president and director of natural product research, enters and announces he has discovered several new molecules in the orchid note. New molecules! Bob perks up.

"That's the story," he enthuses. "Never before smelled by humans."

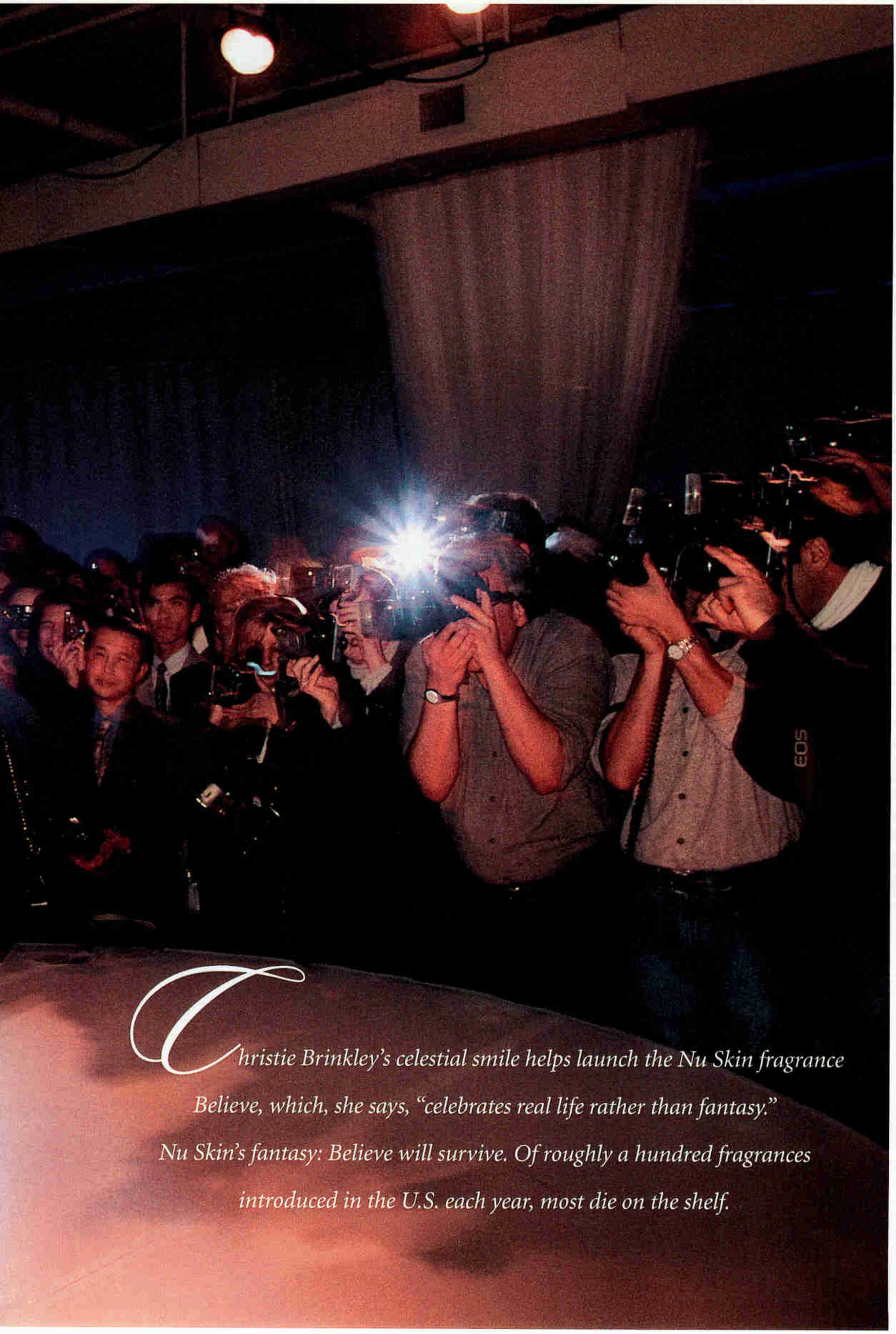


White sheets. Sculpted delts. Deep pockets. Click. Four days and seven figures later Chanel's Allure perfume has a new ad campaign shot by photographer Herb Ritts (above, at right). Red lid. Black leather. Pierced flesh. Image collages "can spur new olfactory ideas," says Jean-Christophe LeGreves of IFF marketing. A hit "juice" can net millions a year in sales.









Christie Brinkley's celestial smile helps launch the Nu Skin fragrance Believe, which, she says, "celebrates real life rather than fantasy." Nu Skin's fantasy: Believe will survive. Of roughly a hundred fragrances introduced in the U.S. each year, most die on the shelf.

The words tumble out nonstop. He's speaking in exclamation points. "We took nothing away from nature but the air! You'll never smell anything like this in your lifetime!"

Sophia Grojsman, the perfumer on the project, sprays a bunch of blotter cards with different submissions and passes them out.

"Number two is muted," she explains. "Seven adds coconut." She sniffs the blotter. "Maybe a little too much coconut."

Aliano likes number five. All heads nod energetically. "I want it bigger, bolder," he says. "I want to make a statement that this is the best. It breaks all the rules. It's PERFECT!

"In fact," he adds, half to himself, "'Perfect' may become the name."

In July, I call Aliano to check on PF1.

"He's no longer here," a secretary says. "He left ten days ago."

I track him down. "I took a golden parachute," he says wearily by phone from California. "I'm sort of tired of this whole industry. Not the creative part," he quickly adds. "It's the strictly numbers attitude. The testing a thing to death. The layers and layers of people.

"PF1 just wasn't going to happen. I hear they've canceled the project."



Behind every great perfume is a great nose. One of the best is Jean Kerleo (above), perfumer for Jean Patou in France. "You have to dream a perfume, imagine it, and have its odors in your mind," says Kerleo, who has memorized hundreds of natural and synthetic raw materials. "It's fabulous to create something that will seduce." For collector Christie Mayer Lefkowith of New York City, owner of the flacons at right, the seduction begins with the bottle.

MARKETING FIRST, then fragrance.

"This is craft, not art," perfumer Annie Buzantian says pragmatically when I ask if the market-driven nature of the business bothers her.

The siren song of advertising leads us to the counter. Last year the industry spent 400 million dollars to trumpet the product. In the never-never land of perfume advertising, the dogs (invariably golden retrievers) never have fleas; no dirty laundry piles up; the grass never needs cutting; there are no pimples or bad hair days. Even the beads of perspiration on the finely muscled torsos look as if they smell not of sweat but of the scent being pitched.

Surely the genius of sell is Calvin Klein. Consider the ads for Obsession: a tangle of bodies (two men, one woman . . . or is it the other way around?). "Repulsive," says a competitor. "But they stick with you. We spent seven million in advertising our product, and in a focus group women said they'd never heard of it."

The Calvin Klein fragrance empire reigns on the 22nd floor of Trump Tower in New York City. I talk to Sheila Hewett, vice president of marketing and advertising.

"The hardest thing is to take something people don't need and make it part of their lives," she explains. "How do you get their attention? You scream loud. You read trends. You look at what's happening."

Take the Gen Xers: target market for cK One and cK Be. "They're wearing fragrance to be part of the group," says Hewett. "They're from divorced families, so friends become more important. There are no rules. It's assimilating to an attitude."

To sell to this group, "you ask what are they reading, what are they



Jean Patou created Normandie in 1935 to commemorate the new luxury liner. The bottle, by architect Louis Süe, was given to all first-class passengers on the ship's maiden voyage.

As if chiseled in ancient stone, the bottle for C'est? by Silka (circa 1920) was designed by art nouveau sculptor Lucien Gaillard. C'est?, shorthand for "What is it?," answers its riddle in small type on the back: Silka.



Boxed in a gilded shell, Elsa Schiaparelli's Le Roy Soleil (1946) came in a Baccarat crystal bottle (seen below the box) depicting a sun atop waves, designed by celebrated surrealist painter Salvador Dalí.



The dawn of the space age inspired Lancôme to put its best-selling Magie perfume in a limited-edition crescent moon bottle designed by Georges Delhomme in 1959.



Captivated by Egyptian themes, Bichara Malhamé put his Ramses II perfume (1928) in an eight-inch bottle reminiscent of the pharaoh's obelisk at Luxor.



Julien Viard's design for Nuit Étoilée de Bagdad by Diamant Bleu (circa 1927) suggests the famed terraced gardens of Babylon, with reflected starlight over the Tigris and Euphrates Rivers.

driving? It's anthropology. You create what they want almost before they know they want it."

The buzzword is global. Flat sales in Europe and the United States prompt a scurry to new markets. Eastern Europe, China, and South America are big. Saudi Arabia has perhaps the highest per capita use (more than a quart a year). Japan is a longed-for market, but a headache. "The Japanese give a status-symbol perfume as a gift. Then it sits on the shelf," frets an executive.

In this global arena the two big players and rivals are France and the United States.

Where is the center of the fragrance universe?

"Paris," says Patrick Choël, general director of Christian Dior Parfums. He sits in a lipstick red leather Le Corbusier chair in his Paris office. "Americans are safe, not experimental," he says, softly and very, very fast. "When you look at some of the successful American brands, you get a lot of crap. We are Dior. We cannot be like that. We are selling the ultimate French good taste."

Dominick Anastasio, president of Fashion Fragrances & Cosmetics,



downs a swallow of coffee in the Edwardian Room of New York's Plaza Hotel and counters, "The French lost their derrieres after World War II. They refuse to accept that 'Made in France' means almost nothing except to a few women anymore."

At a 1995 industry conference in Grasse the tug-of-war erupted in public. The Americans went first and spoke of positioning and how well they understood the global market. The French, just as stridently, claimed they were the center of creativity and experimentation. After much puffing from both sides, Serge Lutens, a makeup designer who has an exquisite perfumery in Paris, got up to speak.

He spoke of mysteries and secrets: the soul of perfume. He spoke of how in Morocco you can get drunk on smelling roses. Of Marie Antoinette in her carriage—the people knew it was she by the scent of her carriage passing in the street. Of Cleopatra and myrrh, and how you can tell the whole of human history through perfume.

Afterward a perfumer stood up and said: "At last, someone speaks of perfume."

So let us speak of perfume and a fragrance so wonderful you fall deeply into it. Let us speak of a perfume so beautiful men will miss you when you leave. Let us speak of perfume and a magic that beguiles us into believing our dreams will come true.

In October I visit Macy's in Manhattan, where a new cologne is to debut. Sally Yeh, president of Bijan Fragrances, the company marketing the scent, inspects the layout, making sure everything is just so.

The product about to be unveiled epitomizes the fragrance-as-aspiration approach. It's Michael Jordan cologne. Where's the face behind the fragrance, the basketball baron Michael Jordan? "He can't do store appearances; he'd cause a riot," Sally explains.

But he's done the media—Oprah, David Letterman, among others, who have flashed the bottle with its sneaker-tread base at the camera. Many jokes from Letterman about the smell of sweat, but, in truth, it smells citrusy and fresh.

Throughout the PR blitz, Jordan smiles his multimillion-dollar smile. Why not? Profits from the sales will make more multimillions.

Seven fragrance models, recruited for the launch, are armed with cologne and poised for action. "Try Michael Jordan cologne. Michael in a bottle," they coo.

Some shoppers brush them off; some offer their wrists. As the day progresses, a woman stops when approached by one of the models, a tall, handsome young man with a majestic tangle of braids.

"Only 23 dollars," he teases.

"I don't have a man to give it to," sighs Denise Gordon, a teacher.

"Don't wait for a man," he urges.

She coolly looks him up and down, then says: "Put some on, baby, and let me check it out."

He obliges, and before you can say personal foul, she grabs and whirls him around the aisle, her face lit up like a Broadway marquee. For a Cinderella instant the store is transformed into a ballroom.

From the sublime . . . to the canine: Parisian groomer Marie Cavalieri D'Oro spritzes clients' dogs and her own Pacha with Chien Chic de Paris, one of many dog perfumes. "It's very gentle, and a pleasant surprise for the owners," she says. Such non-scents were likely not the inspiration for the poet Baudelaire, who wrote of "perfumes fresh as children's flesh, soft as oboes, green as meadows . . . possessing the diffusion of infinite things."

SIX MONTHS after beginning the Cathy perfume project, I meet Ann Gottlieb, the consultant, for lunch and hand her Mirage. She sprays it on her wrist, sniffs, and after a pause says: "It's right on trend. Approachable, pretty, yet doesn't scream." She looks at me. "How do *you* feel about it?"

Like an imposter, I respond. It's *too* pretty.

"Ah," she says. "It's aspirational."

Does the world really need a new fragrance?

Perhaps. Held up against the sad weight of the world, perfume can seem ultimately frivolous. A whiff of costly air. The essence of illusion.

Viewed against that same sad weight, perfume can be wondrously evocative. An elixir to make us forget. Or remember. Or dream. □

Learn more about perfume at *www.nationalgeographic.com/media/ngm/9810.*

Timeless Valleys of the

On a continent of ice
these places are bare.
On a restless planet they
are still. More like Mars
than Earth, Antarctica's
Dry Valleys draw scien-
tists to study primitive
life-forms and to look
through the window
that this changeless
landscape opens into
the depths of time.

Antarctic Desert



By MICHAEL PARFIT
Photographs by MARIA STENZEL

BRUCE MARSH sat outside his tent drinking scotch out of a metal cup, smoking a cigar, and grinning a wicked grin. He looked like a young Fidel Castro celebrating victory, but what pleased him was not revolution but time.

"No trees," he said. "No green plants. Just blue-green algae. Where else can you go where it's just like it was three billion years ago? Incredible!"

Marsh, a Johns Hopkins University geologist, was camped with four colleagues and me on a gravel shelf below a hillside covered with rocks shaped by wind into what looked like enormous skulls, above a valley in which were scattered freeze-dried carcasses of seals. They had crawled up here by mistake from nearby McMurdo Sound and had died as long ago as 3,000 years. Yet what Marsh found incredible was not the vivid strangeness of this little piece of Antarctica called the McMurdo Dry Valleys, but the way this place uses a kind of amber of coldness and dryness to catch the traces of time.

Ninety-eight percent of Antarctica is covered with ice up to three miles thick. Most of the 2 percent left is made up of mountain peaks or sea-scoured coastlines. The Dry Valleys area is different. The name applies to a region that includes about 1,500 square miles of bare ground, which, because winds blast away snow and keep precipitation out, doesn't build ice. The area is dominated by three parallel valleys:

MICHAEL PARFIT, a frequent contributor, is the author of *South Light: A Journey to the Last Continent.* MARIA STENZEL first learned about the Dry Valleys when photographing Antarctica's sea ice for the May 1996 issue.



"It takes a while to get at ease in this place," says Johns Hopkins University geologist Bruce Marsh, second from left, resting in camp with his student team after a day of gathering rock samples. "We never see formations so sculpted by wind anywhere else on Earth," he says. "For geologists it's all very odd, until you understand that this is very ancient terrain."

Victoria, Wright, and Taylor. There are several large lakes in these valleys and a number of ponds. Many are frozen clear to the bottom, though one has 77°F water deep below its ten-foot-thick ice ceiling, because dense layers of salty water trap the slight summer heat. A single 18-mile-long river flows with glacial melt for one or two months each year. The average annual temperature here is minus 4°F, and the average precipitation—all snow—equals less than four inches of water a year.

Every Antarctic spring, even before the sun lifts clear of the horizon for its three-month-long summer day, about 75 intensely focused scientists like Bruce Marsh, brought here by the U.S. National Science Foundation or by other nations' research organizations, converge on the Dry Valleys. There is much to draw them: Microscopic worms at the top of the food chain, life that survives being freeze-dried, great slabs of rock that would elsewhere be hidden to geologists by plants, evidence of the history of the climate hidden in the ash of ancient volcanoes. But the different scientists share one thing—this stark place, which has changed little in millions of years, gives them a chance not just to check out a curious part of the Earth but also to explore the far reaches of time itself.

"Rocks are the history books of the planet," said Marsh, pausing in his climb up a slope of broken black basalt. "Everywhere else you get rain and decaying plants, and the rocks get altered. Here the rocks have been kept cold and dry, and they're just like the day they were formed. It's like walking into a beautifully maintained Alexandrian library from 100 B.C. The same kind of thrill."

The six of us were working our way up a steep hillside, taking chunks from a band of stone that had been formed from magma deep in the Earth about 180 million years ago. As usual the view around us was spacious and grand: Below us lay a stony valley that swept far out and upward to ridges of pale brown and black layers of rock. Beyond that the luminous whiteness of the East Antarctic ice sheet flowed right up to the ridges that surround the Dry Valleys like a reservoir lapping up behind a dam. The cold air was so clear it was hard to imagine there was a single molecule of anything in the sky between us and the South Pole.

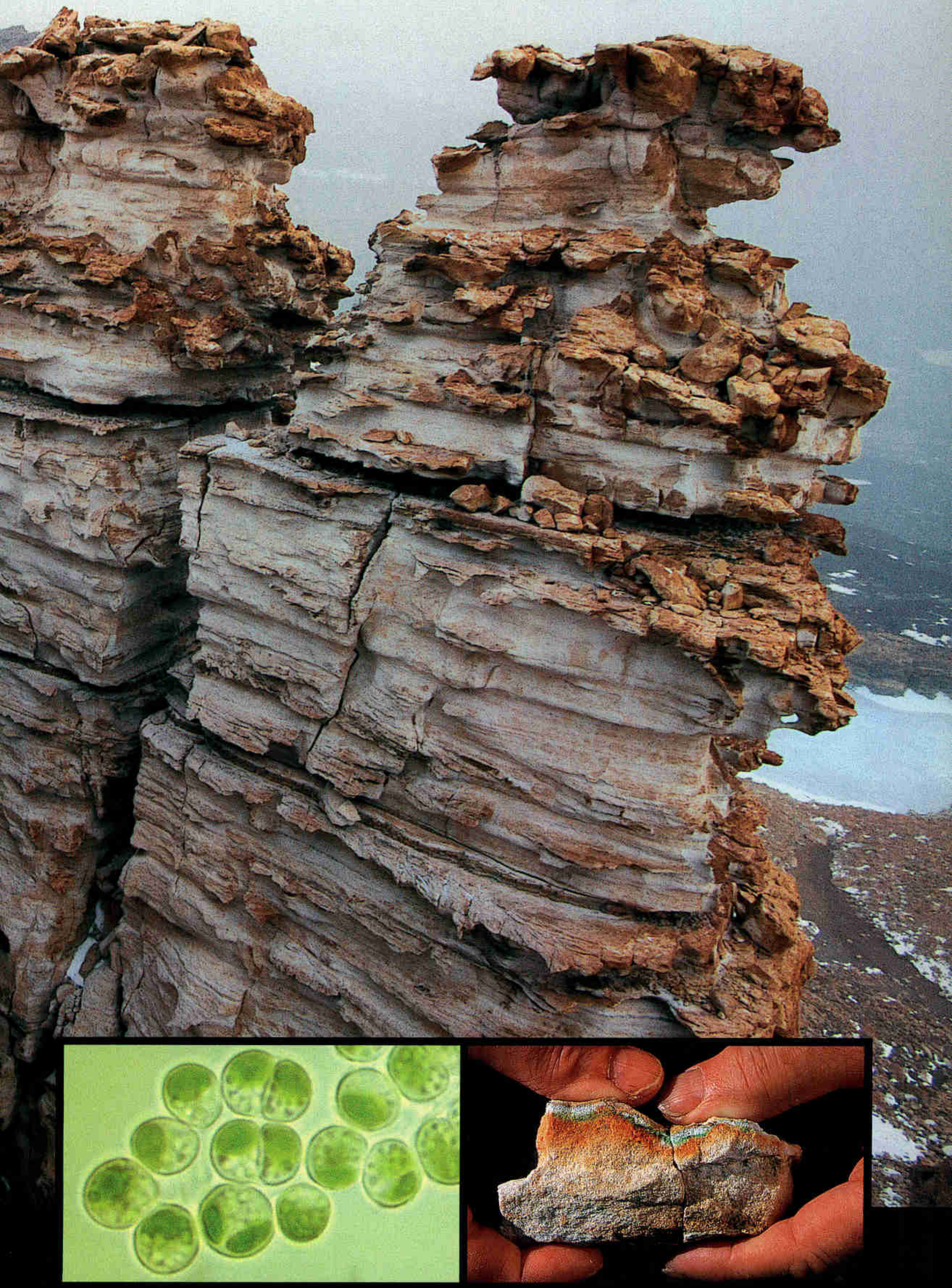
Marsh chopped a chunk off a boulder and put it in his pack, which was already about 30 pounds heavier than when he started. What he wanted to learn from this load went much farther back than just 180 million years. He was trying to understand the basic processes that made the planet's surface.

Marsh, who loves to explain his complex science with everyday metaphors, now talked about walking through an automobile junkyard: If you didn't know what cars were, he said, you'd have a hard time figuring out just what all those pieces of metal had come from. To geologists, most of the world is the junkyard, hard to interpret. But in the Dry Valleys you can tour the whole factory.

"There are rocks just like this at Gettysburg, Pennsylvania," Marsh said. "But we can't see much of them. The very completeness here allows us to flesh out the overall scope of

Life between the crystals

On a high promontory microbiologists Imre Friedmann and Silvano Onofri examine life inside the rock. A community of algae, fungi, and bacteria colonizes damp spaces between crystals of porous sandstone. Algae and fungi form a white lichen layer above a green layer of algae (inset, far right). The algal species *Hemichloris antarctica* (inset, right) "is insensitive to repeated freezing and thawing," Friedmann says. "We think microscopic niches like these could have been the last footholds for life on a drying and cooling Mars," he says.



E. IMRE FRIEDMANN (INSET, LEFT)

how volcanoes and magma work in the Earth."

The long story that Marsh seeks is not just for geologists. Those who study life can find some of the oldest living things on Earth and some of the most ancient species.

One collection of unusually old—and tough—species was discovered in the mid-1970s by microbiologists Imre Friedmann, from Florida State University, and Roseli Ocampo-Friedmann, from Florida A&M. On a ridge above the Victoria Valley they found an entirely unexpected community of microscopic algae, fungi, and bacteria living *inside* rocks.

These microorganisms live in the minute gaps between the grains of sandstone, about a sixteenth of an inch under the surface, where they can get a little light, a little moisture, and a little sustenance from the mineral that encloses them. The tiny fragments of life can be thousands of years old, more ancient than the greatest of trees in the oldest forests. That does not necessarily indicate that they are thriving.

"They're always cold, always hungry, like families living in the gutter," Friedmann said. "They live in continuous misery, so to say. They're near to the absolute limit."

So is everything that lives here.

"This is a pretty extreme place for life," says Robert Wharton, of Nevada's Desert Research Institute. Wharton ran the McMurdo Dry Valleys Long Term Ecological Research project, which incorporates much of the research being done here into an overall framework designed to make the information gathered useful in predicting things like climate change. "If you turned the thermostat down just a little," Wharton said, "everything would freeze up. We're exploring the outer reaches of life."

To do this exploration, scientists go to extremes themselves.

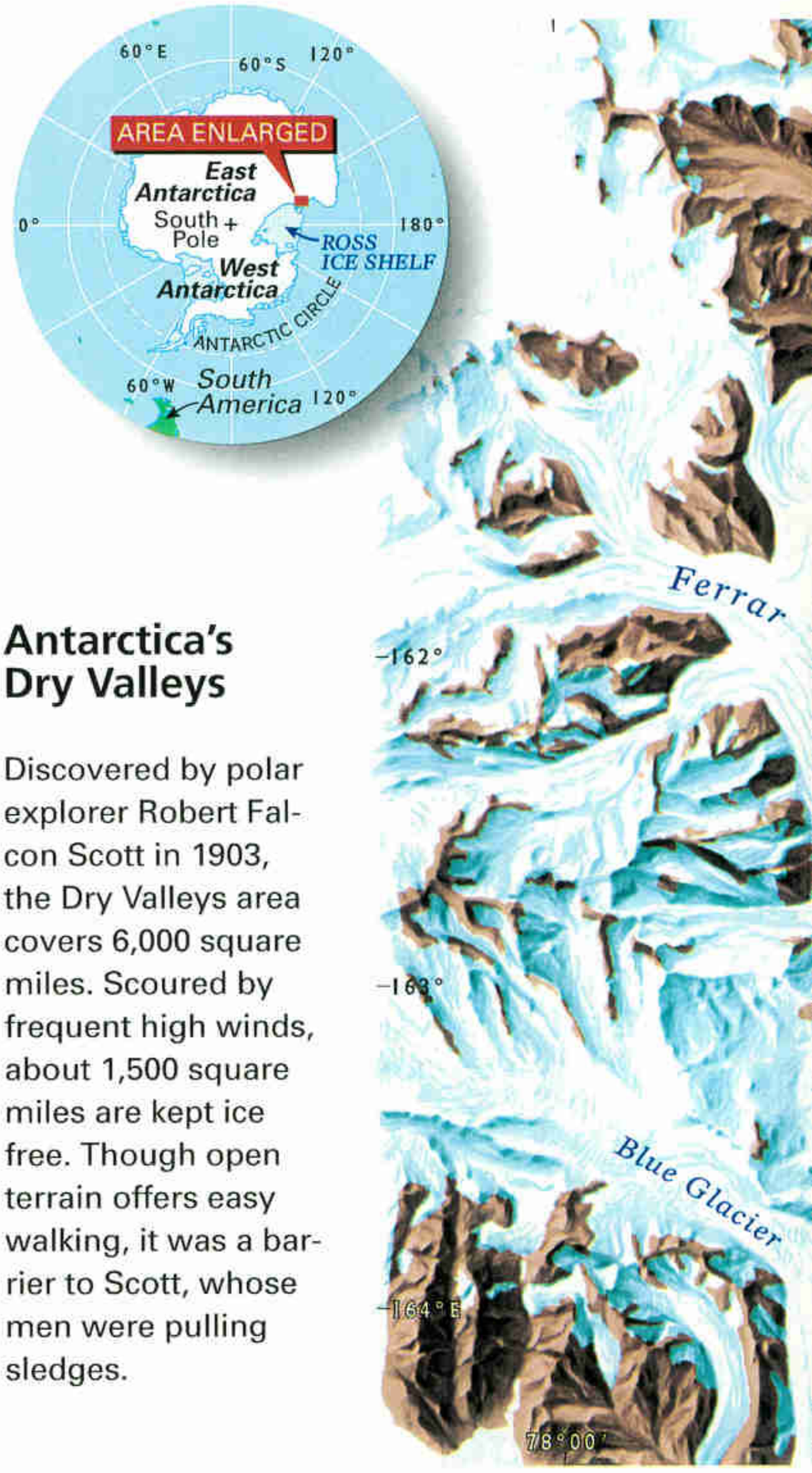
"Sometimes you participate in something," said Nick Lancaster, in his deliberate British accent, "and you think: I don't want to do this."

Lancaster, also from the Desert Research Institute, was standing at the edge of a hole in the ice of a small lake, drawing rope out of the water. The rope was stiff as cable, frozen as soon as it emerged. At the end of the rope was Dale Andersen, doing the chilling job that Lancaster, here to study wind erosion, did not envy.

Andersen, a diver working for Bob Wharton's project, seemed to love it. He was on the bottom of the lake, 70 feet down, wearing a dry suit and scuba gear, gathering algae samples. He was apparently impressed with how big the growth was, and how little of it he could get into his sample bottles. His excited voice came gurgling up to us through an intercom in his mask.

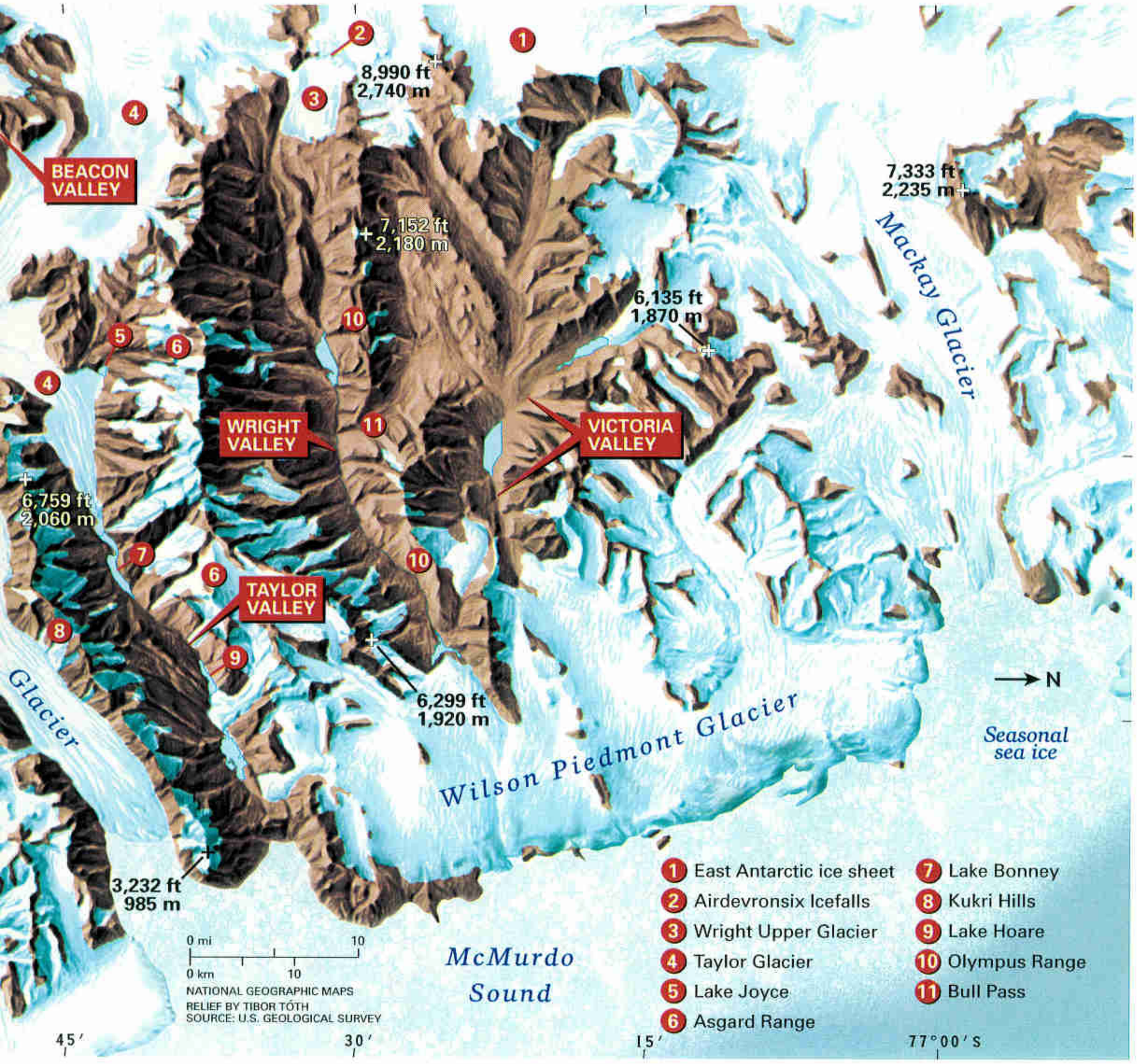
"I'm going to put three of these things . . . *gasp* . . . in the bottles," the voice said. *Gasp.* "These are just the babies."

The lake was called Joyce and lay in one of the most spectacular settings I have seen anywhere. On one side of the lake was a wall of ice more than a hundred feet high, the cliff edge of a glacier that flowed down into the Taylor Valley from the continental ice sheet above. Everywhere around us dark bare rock rose in violent peaks, ridges, and pinnacles. Everything was jagged, except for the line drawn by the surface



Antarctica's Dry Valleys

Discovered by polar explorer Robert Falcon Scott in 1903, the Dry Valleys area covers 6,000 square miles. Scoured by frequent high winds, about 1,500 square miles are kept ice free. Though open terrain offers easy walking, it was a barrier to Scott, whose men were pulling sledges.



of the glacier. That long simple edge, which seemed to glow with all the light the sun could give it, was a smooth white curve miles long, as precise and subtle as the curvature of the Earth.

Over several years Andersen had been diving in the lakes here. Each one looked much the same on the surface—sheets of ice that thaw slightly around the edges for a short time each summer. But each lake, formed by seepage of small amounts of groundwater and seasonal melting of glaciers, has a different chemical content and water temperature. Some of them are salty, but in varying degrees. One pond has such a high concentration of salts—far more than Utah's Great Salt Lake—that it doesn't freeze all winter, in spite of temperatures that drop to 60 degrees below zero.

Until 1978 most scientists thought the lake bottoms were almost barren. "They said you're not going to find anything but rocks," Andersen remembers. Then George Simmons, a National Science Foundation grantee, decided to dive to the bottom of Lake Hoare. Andersen, working for Simmons, was there.

"I'll never forget it," Andersen said. "He got to the bottom, and his eyes got used to the darkness, and he started shouting over the intercom: 'Mat! Mat! Mat! Mat everywhere!' We thought he was in trouble."

What Simmons was talking about was blue-green algae, a primitive form of bacteria. The algae—which can be orange or black as well as blue-green—live in what scientists call a microbial mat, a community of many species. These kinds of (*Continued on page 132*)

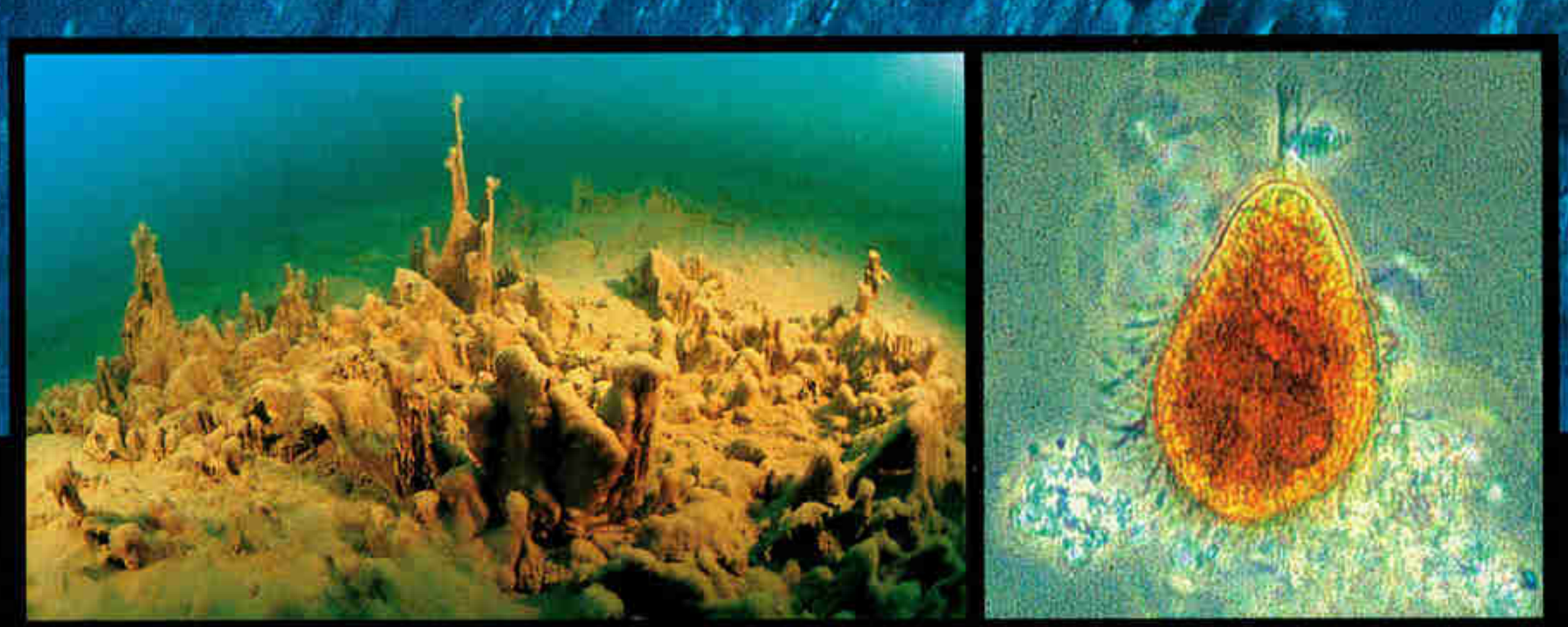


Odd predator in a cold desert

Taylor Glacier, its snout reddened by iron, drains into Lake Bonney. Snow and ice collect at higher elevations, but the valleys are as dry as the Gobi desert; temperatures average minus 4°F.

The lion of this land, the creature at the top of the food chain, is a bacteria-eating nematode (inset), a microscopic worm that can survive years of being freeze-dried.





DALE ANDERSEN (INSET, LEFT); JOHN PRISCU (INSET, ABOVE)

Unlikely greenhouse

Biologists lower a bottle through a hole drilled in 12 feet of ice to collect water samples and microorganisms from Lake Bonney. Dirt blown onto the lake absorbs solar heat and melts into the permanent ice cover, creating dark blotches. Around the dirt, tiny pockets of melted water support microbial life. When the water refreezes, bubbles form that help block light and force phytoplankton such as *Chlamydomonas subcaudata* (inset, left) and large mats of algae on lake floors (far left) to adapt to near darkness.

algae are some of the oldest life-forms on Earth; they are thought to have been one of the original sources of the oxygen in our air. Yet they're hard to study elsewhere, because in most other places mats like these must compete with other organisms. As with Bruce Marsh's geology, the uncluttered starkness of the Dry Valleys allows an unusually close look.

"There are few places where you can find strictly microbial mat communities like this," Andersen said. "It's like diving back in time."

Algae have various ways of dealing with the Dry Valleys' slow, harsh chronology. A few years ago Diane McKnight, an ecologist with the University of Colorado at Boulder who studies algae with Wharton's group, wondered if some of the algae could survive a long time without liquid water. This question not only is germane to our planet but also could relate to the question of life on Mars, which the Dry Valleys resemble more than many places on Earth. So McKnight built a sandbag dam across a stream to run water into an old channel.

"In 1969," McKnight told me as we followed the water, "aerial photographs showed water in this channel. By 1981 more photos showed it was dry." When she walked down the channel before turning water into it, there were only a few pockets of very dead-looking algae.

When the languid stream moved back into the dry channel, McKnight held her breath. Some of her colleagues questioned whether the experiment was worthwhile, and as she waited for something to happen in the water, she wondered if perhaps they were right.

There were plenty of other indications that life has developed extraordinary strategies to survive here. Diana Wall, a Colorado State University biologist who studies nematodes—microscopic worms—found that they go into a dry, lifeless state called anhydrobiosis when moisture leaves. Dried out, they start to look like night crawlers on the driveway when the puddles go away, except the nematodes are not exactly dead. When the tiny bit of wetness from a light snowfall or a brief melt comes along, the nematodes emerge from their freeze-dried state and go back to eating bacteria.

"It's like the fountain of youth," Wall once told me with a grin. "You just go into anhydrobiosis and wait."

McKnight knew about her colleagues' work with other life that survived long periods of dry cold, but she remained unsure what to expect from her experiment. She didn't have long to worry. Only a week after the water had been turned into the old channel, telltale orange and black colors burst forth along the watercourse.

Was this how life had hung on in the early Earth's harshness? Was it how life might possibly still survive on Mars? Those were speculations for another kind of study. Right now it was enough that these algae, which had looked like dust, were practically in flower.

McKnight and I stood beside the easy flow of the stream, looking at the stain of life along the wet rocks.

"I guess I hadn't gone out on a limb as much as I'd thought," McKnight said.

To me it was life itself that seemed out on a limb here. I thought about these same kinds of algae getting established on the early face of Earth, in places that may have looked a lot like this—bare rock, parched sky, and not much hope of anything better for a billion years. I thought of the hills near my home, now completely covered with abundant green, all because stuff like this stain on the rocks hung on through the hard times. We come from stubborn stock.

McKnight and I walked quietly back toward her camp next to the stream. Beside us the water slipped down toward the lake, sparkling in the sun, awakening elemental life, as if it held in its miraculous fluid the gathered light-years of a million stars.

THE MORE PEOPLE LEARN about this deceptively simple-looking place, the more complexities they find. One day Andrew Fountain, a glaciologist from Portland State University in Oregon, and I went out with crampons and ice ax. He is studying the way water gets to the Dry Valleys from glaciers, trying to tie that into the way the climate works here. Fountain had 90 stakes on six glaciers in the valleys, measuring the ways the ice grows and shrinks. He found that the climate patterns he hoped to understand differed subtly from glacier to glacier. The amount of snow that fell on neighboring glaciers, for instance, may have been significantly affected just by a little hill in the middle of the valleys.

"What started out to be a very simple problem," he said, "turns out not to be. The whole thing is a matter of nuance."

Sometimes the nuances of scene and time were so immense they were staggering. Once, when I was hiking with Jamie Pierce, a mountaineer with experience on all seven continents, he stopped, looked around, and gave up trying to take it all in. "My mind's on overload," he said. "This is, like, nuts."

Above us was a steep tumble of ice where the ice sheet of the Antarctic interior falls across the ridges and drops a blue puddle called the Wright Upper Glacier into the edge of the Dry Valleys. The falls are called Airdevronsix Icefalls after the Navy squadron that has worked in Antarctica since 1956.

This was a Niagara of ice, but much bigger. It was over three miles wide and more than 500 feet high. Huge chunks of ice cascaded down the falls; it looked as if New York City had been turned into salt blocks and shoved into the Grand Canyon. But the thing that really got me was that no matter how long I looked at it, nothing moved.

I watched and watched. The blocks were impossibly tilted, the angle impossibly steep. Things should be tumbling, crashing, thundering. But nothing moved. Time was roaring along out there, but we couldn't hear it.

"FIVE DEGREES RIGHT!" Dave Marchant said into his headset's mike as a National Science Foundation helicopter clattered up a valley tiled with polygons created in loose rock by the flexing of frost. "Five degrees left! There! That's all Pleistocene there. Ten left!"

Marchant is a geologist from Boston University. He's a time detective. Marchant's current specialty is using volcanic ash to study the age of landscapes. Since ash can be dated more accurately than most other ancient materials because of the way isotopes in it mark the time passed since it was formed, any ash found where it fell is a tag marking the flow of time.

Marchant's tags have become critical lately because of a new theory that the deep sheet of ice that covers East Antarctica melted away as recently as three million years ago. This may not seem exactly yesterday, but in the Dry Valleys context it's just a couple of moments past. This idea would mean that Antarctica's entire ice cover is much more unstable than previous theories would have it.

The bottom line is this: If the Antarctic ice sheet, which holds as much as 70 percent of the world's fresh water, is that prone to melt, then global warming could raise sea levels by feet instead of inches, inundating coastlines around the world.

Marchant and others do not agree with this theory. Because the ash has been where it landed for far more than three million years, he thinks the Dry Valleys—and the adjacent ice sheet—have been much as they are for a lot longer than the melt theory would allow.

One morning when a blizzard kept us in camp, Marchant read me a short poem he wrote years ago:

By the questions we pose
Ourselves we deceive
So limited in thought
By what we choose to perceive.

Marchant laughed at the poem but wanted me to take it seriously. Its edge—a warning about blind spots in science—is his reaction to the debate about melting.

Later he and I sat on a rock in a valley of polished desert stones, and he talked about how rocks here are shaped by the brush of wind and the slow interaction of moisture and chemicals.

"A drop of water forms on the rock," he said. "Every drop carries dissolved salt from the sea. The drop slides under the rock and falls off. Thousands of years later, and there's a grain of salt. Any stone probably has millions of years of salt under it."

I picked up a flat stone. Under it was a little heap of salt. I felt as if I had disturbed the sleep of something. I put the rock back.

That salt was eerie. It reminded me of the dead seals and of the skull-shaped rocks behind Bruce Marsh's camp. This whole place is like an ancient skull, I thought, once a piece of the vibrant life of the Earth, now abandoned by the warmth and wetness that keeps the rest of the planet teeming with life. This skull is dried out and left to bleach, but we can pick it up off the ground where it's been lying for ten million years, stare like Hamlet into its strangely expressive shadow eyes, and know that there are many things hidden in time that we have yet to learn.

Marchant grinned at my amazement. He'd seen the Dry Valleys do this to others too.

"First you think there's nothing here, don't you?" he said. "Then there is too much."

A giant jigsaw puzzle of stone and soil shaped by frost paves Beacon Valley. The age of volcanic ash here shows little has changed in millions of years. "Antarctica holds the answers," says geologist Dave Marchant, who seeks clues to Earth's past. "They're just hidden." □







■ FROM THE GEOGRAPHIC ARCHIVES

Still Magnolias

Artfully arranged by their dance teacher as a "living mural," these students spent hours posing on a theater curtain spread across the lawn of Mississippi State College for Women, in Columbus. Photographer J. Baylor Roberts leaned off a dormitory roof to shoot them for his "Magnolia State Mosaic," a portfolio of color plates published in September 1937.

Their silk dresses were strictly dance-department issue. "We were sheltered girls," recalls Dale Baker Doherty, at left. "Ordinarily we wore solid navy blue uniforms on campus," she says, "though sophomore year you could have a little white embroidery on your collar."

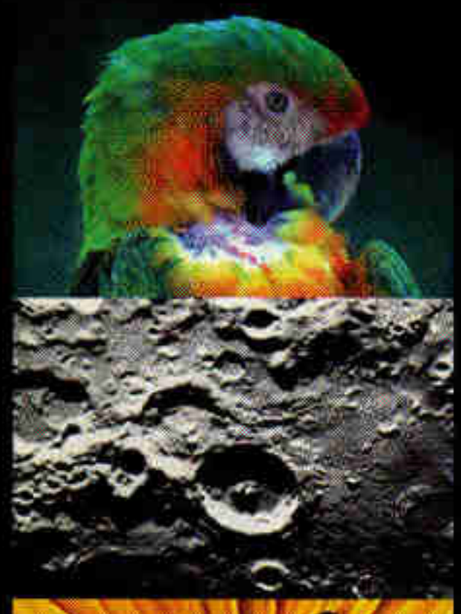
"We were allowed to put on makeup and perfume," says Jane Bullock Carson, at right, "just not much."

Doherty and Carson, both now 80, remember the photographer as a perfect gentleman. "Although I have to say," adds Doherty, "I thought it was pretty silly to have us lying on the ground like that."

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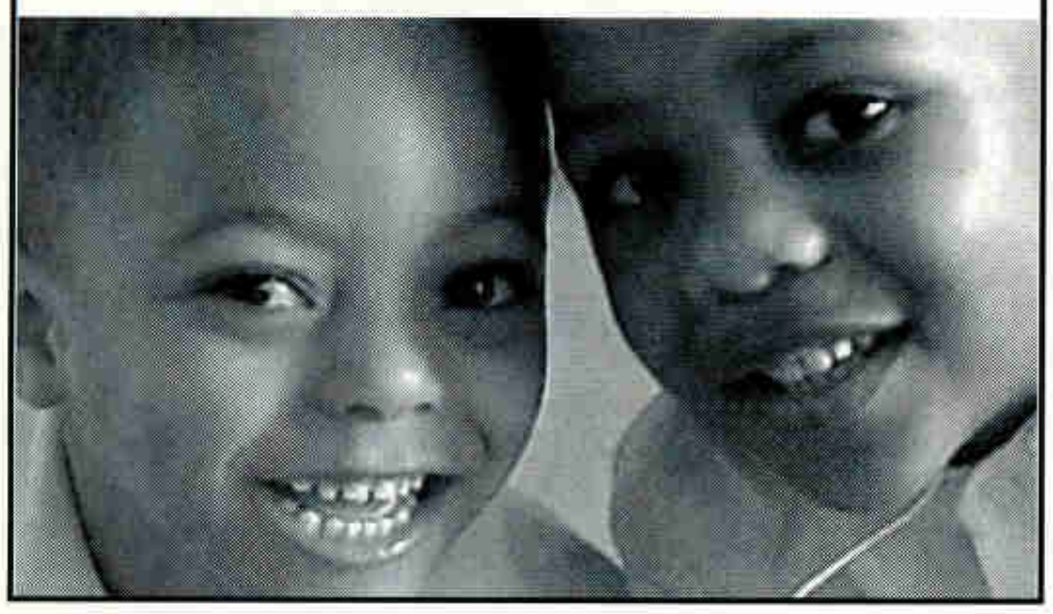
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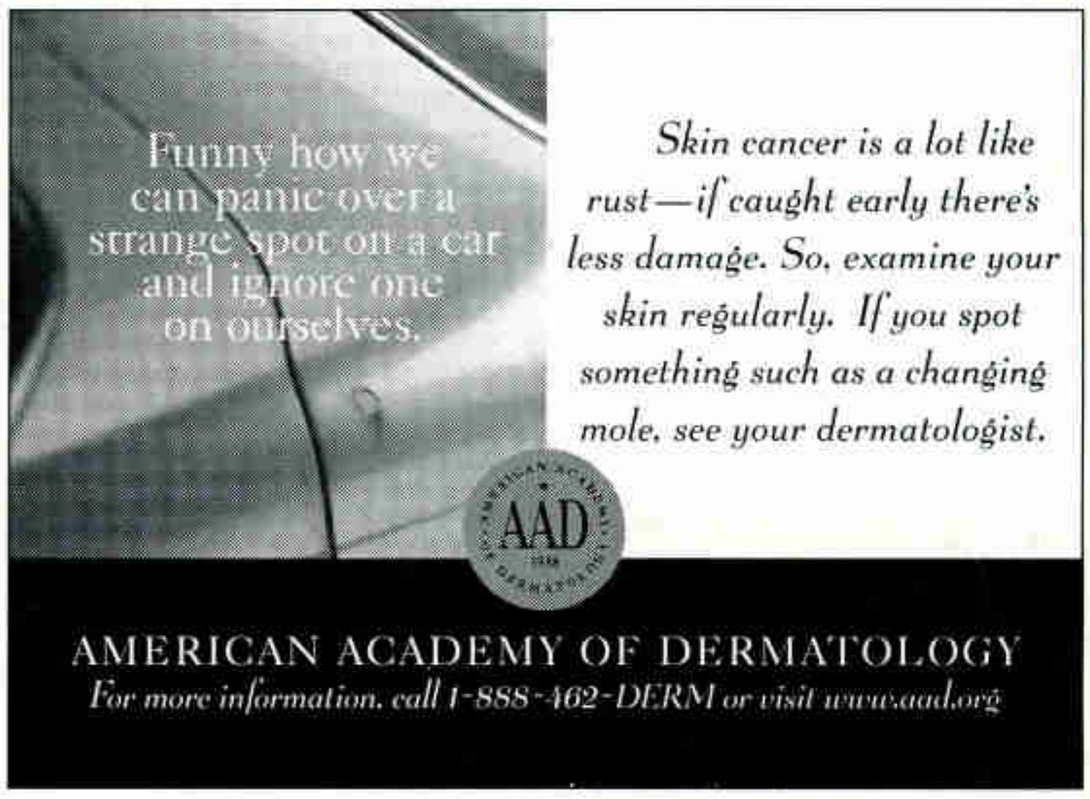
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On Screen







■ EXPLORER, OCT. 11

Predators Purr Excellence

It's 8 p.m. Do you know where your kitty is? Even pampered, well-fed cats like Rush (right), who every evening enjoys dinner at the table with his doting owners—complete with candles, crystal, and china—have wildness coursing in their veins.

EXPLORER takes a look at *The Secret Life of Cats* and finds that Felix has dethroned Fido as the most popular pet in the United States and much of Europe. In 20 years the number of house cats in the U.S. has doubled, and within each of these beloved companions beats the heart of a hunter.

"Ironically," the film notes, "the cat's ticket to domestication lay in its very wildness—its remarkable ability to hunt." This was once a boon for controlling rats aboard sailing ships, but with more than a hundred million cats now prowling the U.S., what are the consequences for birds and small mammals?

Ting Tang II, a Siamese, lives on a farm in southern Virginia with his owner, ornithologist Ruth Beck, who loves both her cat and birds. When she found that Ting was presenting her with about a bird a morning, Beck put her nighttime marauder on a strict curfew. "Our pets," Beck says, "are also predators."



PAVEL GERMAN, NATURE FOCUS (TOP CENTER); TRIA THALMAN

Finding the right balance between cats and wildlife sometimes makes people go at it tooth and claw. Nowhere is the debate more intense than in Australia, where cats have colonized the entire continent, putting many native animals at risk. Millions of feral cats roam the country, and they don't read the endangered species list before they pounce. This cat on the hunt (top center) brings down an endangered bridled nailtail wallaby.

Britain's Mammal Society conducted a survey titled "Look What the Cat Brought In," and *The Secret Life of Cats* features Missy, a Dorset puss revealed by the survey to be one of the U.K.'s most prolific hunters of birds, mice, voles, and rabbits.

Many humans love their stealthy and often haughty felines—from aristocats like the tortoiseshell Persian Marcus M'Donna (top left), Best in Show at the Crab and Mallet Cat Club Show in Baltimore, Maryland, to a tumbling litter of barn kittens (top right). Cats, though, have their own notions about affection and what they take to be their just desserts.

■ PROGRAM GUIDE

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All-day, all-night relief in one tablet.
Relieves *all* seasonal allergy symptoms for ages 12 years and older: stuffy nose; itchy, watery eyes; runny nose; itchy ears/palate; and sneezing.

There are some people who should not take CLARITIN-D® 24 HOUR. You should not use this product if you have a history of difficulty in swallowing tablets or any medical problems associated with swallowing abnormalities. Other people need to be especially careful using it. Therefore, be sure to tell your healthcare provider if you have high blood pressure, heart disease, diabetes, glaucoma, thyroid or liver problems, or difficulty urinating, or if you are taking MAO inhibitors (prescription medicines that treat depression), or if you become pregnant or are nursing a baby. Also, CLARITIN-D® 24 HOUR must not be chewed or broken.

CLARITIN-D® 24 HOUR contains pseudoephedrine sulfate, which also is in many over-the-counter (OTC) and prescription medications. Too much pseudoephedrine sulfate can cause nervousness, sleeplessness, dizziness, and other related side effects. Therefore, you shouldn't use both CLARITIN-D® 24 HOUR and OTC antihistamines and decongestants at the same time.

CLARITIN-D® 24 HOUR is available by prescription only.

Lets you be alert during the day and sleep at night.
In studies, the incidence of drowsiness was 6% vs sugar pill, 4%; the incidence of sleeplessness was 5% vs sugar pill, 1%. Dry mouth was the most commonly reported side effect with CLARITIN-D® 24 HOUR (8% vs sugar pill, 2%).

For a $5.00 rebate certificate and important free information about relief of nasal congestion and other seasonal nasal allergy symptoms,

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Once-a-day

Claritin-D® 24 Hour

(10 mg loratadine/240 mg pseudoephedrine sulfate, USP) Extended Release Tablets

Please see next page for additional important information.

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CLARITIN-D® 24 HOUR
brand of loratadine and pseudoephedrine sulfate, USP
Extended Release Tablets

BRIEF SUMMARY
(for full Prescribing Information, see package insert.)

INDICATIONS AND USAGE: CLARITIN-D 24 HOUR Extended Release Tablets are indicated for the relief of symptoms of seasonal allergic rhinitis. CLARITIN-D 24 HOUR Extended Release Tablets should be administered when both the antihistaminic properties of CLARITIN® (loratadine) and the nasal decongestant activity of pseudoephedrine sulfate are desired (see **CLINICAL PHARMACOLOGY** section).

CONTRAINDICATIONS: CLARITIN-D 24 HOUR Extended Release Tablets are contraindicated in patients who are hypersensitive to this medication or to any of its ingredients.

This product, due to its pseudoephedrine component, is contraindicated in patients with narrow-angle glaucoma or urinary retention, and in patients receiving monoamine oxidase (MAO) inhibitor therapy or within fourteen (14) days of stopping such treatment. (See **PRECAUTIONS: Drug Interactions** section.) It is also contraindicated in patients with severe hypertension, severe coronary artery disease, and in those who have shown hypersensitivity or idiosyncrasy to its components, to adrenergic agents, or to other drugs of similar chemical structures. Manifestations of patient idiosyncrasy to adrenergic agents include: insomnia, dizziness, weakness, tremor, or arrhythmias.

WARNINGS: CLARITIN-D 24 HOUR Extended Release Tablets should be used with caution in patients with hypertension, diabetes mellitus, ischemic heart disease, increased intraocular pressure, hyperthyroidism, renal impairment, or prostatic hypertrophy. Central nervous system stimulation with convulsions or cardiovascular collapse with accompanying hypotension may be produced by sympathomimetic amines.

Use in Patients Approximately 60 Years of Age and Older: The safety and efficacy of CLARITIN-D 24 HOUR Extended Release Tablets in patients greater than 60 years old have not been investigated in placebo-controlled clinical trials. The elderly are more likely to have adverse reactions to sympathomimetic amines.

PRECAUTIONS: General: Because the doses of this fixed combination product cannot be individually titrated and hepatic insufficiency results in a reduced clearance of loratadine to a much greater extent than pseudoephedrine, CLARITIN-D 24 HOUR Extended Release Tablets should generally be avoided in patients with hepatic insufficiency. Patients with renal insufficiency (GFR <30 mL/min) should be given a lower initial dose (one tablet every other day) because they have reduced clearance of loratadine and pseudoephedrine.

Information for Patients: Patients taking CLARITIN-D 24 HOUR Extended Release Tablets should receive the following information: CLARITIN-D 24 HOUR Extended Release Tablets are prescribed for the relief of symptoms of seasonal allergic rhinitis. Patients should be instructed to take CLARITIN-D 24 HOUR Extended Release Tablets only as prescribed and not to exceed the prescribed dose. Patients should also be advised against the concurrent use of CLARITIN-D 24 HOUR Extended Release Tablets with over-the-counter antihistamines and decongestants. Patients who have a history of difficulty in swallowing tablets or who have known upper gastrointestinal narrowing or abnormal esophageal peristalsis should not use this product.

This product should not be used by patients who are hypersensitive to it or to any of its ingredients. Due to its pseudoephedrine component, this product should not be used by patients with narrow-angle glaucoma, urinary retention, or by patients receiving a monoamine oxidase (MAO) inhibitor or within 14 days of stopping use of an MAO inhibitor. It also should not be used by patients with severe hypertension or severe coronary artery disease.

Patients who are or may become pregnant should be told that this product should be used in pregnancy or during lactation only if the potential benefit justifies the potential risk to the fetus or nursing infant.

Patients should be instructed not to break or chew the tablet and to take it with a glass of water.

Drug Interactions: No specific interaction studies have been conducted with CLARITIN-D 24 HOUR Extended Release Tablets. However, loratadine (10 mg once daily) has been safely coadministered with therapeutic doses of erythromycin, cimetidine, and ketoconazole in controlled clinical pharmacology studies. Although increased plasma concentrations (AUC 0-24 hrs) of loratadine and/or descarboethoxyloratadine were observed following coadministration of loratadine with each of these drugs in normal volunteers (n = 24 in each study), there were no clinically relevant changes in the safety profile of loratadine, as assessed by electrocardiographic parameters, clinical laboratory tests, vital signs, and adverse events. There were no significant effects on QT_c intervals, and no reports of sedation or syncope. No effects on plasma concentrations of cimetidine or ketoconazole were observed. Plasma concentrations (AUC 0-24 hrs) of erythromycin decreased 15% with coadministration of loratadine relative to that observed with erythromycin alone. The clinical relevance of this difference is unknown. These above findings are summarized in the following table:

Effects on Plasma Concentrations (AUC 0-24 hrs) of Loratadine and Descarboethoxyloratadine After 10 Days of Coadministration (Loratadine 10 mg) in Normal Volunteers

	Loratadine	Descarboethoxyloratadine
Erythromycin (500 mg Q8h)	+ 40%	+46%
Cimetidine (300 mg QID)	+103%	+ 6%
Ketoconazole (200 mg Q12h)	+307%	+73%

There does not appear to be an increase in adverse events in subjects who received oral contraceptives and loratadine.

CLARITIN-D 24 HOUR Extended Release Tablets (pseudoephedrine component) are contraindicated in patients taking monoamine oxidase inhibitors and for 2 weeks after stopping use of an MAO inhibitor. The antihypertensive effects of beta-adrenergic blocking agents, methyldopa, mecamylamine, reserpine, and veratrum alkaloids may be reduced by sympathomimetics. Increased ectopic pacemaker activity can occur when pseudoephedrine is used concomitantly with digitalis.

Drug/Laboratory Test Interactions: The *in vitro* addition of pseudoephedrine to sera containing the cardiac isoenzyme MB of serum creatinine phosphokinase progressively inhibits the activity of the enzyme. The inhibition becomes complete over 6 hours.

Carcinogenesis, Mutagenesis, Impairment of Fertility: There are no animal or laboratory studies on the combination product loratadine and pseudoephedrine sulfate to evaluate carcinogenesis, mutagenesis, or impairment of fertility.

In an 18-month carcinogenicity study in mice and a 2-year study in rats loratadine was administered in the diet at doses up to 40 mg/kg (mice) and 25 mg/kg (rats). In the carcinogenicity studies pharmacokinetic assessments were carried out to determine animal exposure to the drug. AUC data demonstrated that the exposure of mice given 40 mg/kg of loratadine was 3.6 (loratadine) and 18 (active metabolite) times higher than in humans given the maximum recommended daily oral dose. Exposure of rats given 25 mg/kg of loratadine was 28 (loratadine) and 67 (active metabolite) times higher than in humans given the maximum recommended daily oral dose. Male mice given 40 mg/kg had a significantly higher incidence of hepatocellular tumors (combined adenomas and carcinomas) than concurrent controls. In rats, a significantly higher incidence of hepatocellular tumors (combined adenomas and carcinomas) was observed in males given 10 mg/kg and in males and females given 25 mg/kg. The clinical significance of these findings during long-term use of loratadine is not known.

Two-year feeding studies in mice and rats conducted under the auspices of the National Toxicology Programs (NTP) uncovered no evidence of carcinogenic potential of ephedrine sulfate at doses up to 10 and 27 mg/kg, respectively (approximately 16% and 100% of the maximum recommended human daily oral dose of pseudoephedrine sulfate on a mg/m² basis).

In mutagenicity studies with loratadine alone, there was no evidence of mutagenic potential in reverse (Ames) or forward point mutation (CHO-HGPRT) assays, or in the assay for DNA damage (Rat Primary Hepatocyte Unscheduled DNA Assay) or in two assays for chromosomal aberrations (Human Peripheral Blood Lymphocyte Clastogenesis Assay and the Mouse Bone Marrow Erythrocyte Micronucleus Assay). In the Mouse Lymphoma Assay, a positive finding occurred in the nonactivated but not the activated phase of the study.

Decreased fertility in male rats, shown by lower female conception rates, occurred at 64 mg/kg of loratadine (approximately 50 times the maximum recommended human daily oral dose based on mg/m²) and was reversible with cessation of dosing. Loratadine had no effect on male or female fertility or reproduction in the rat at 24 mg/kg (approximately 20 times the maximum recommended human daily oral dose on a mg/m² basis).

Pregnancy Category B: The combination product loratadine and pseudoephedrine sulfate was evaluated for teratogenicity in rats and rabbits. There was no evidence of teratogenicity in reproduction studies with this combination of the same clinical ratio (1:24) at oral doses up to 150 mg/kg (approximately 5 times the maximum recommended human daily oral dose on a mg/m² basis) in rats, and 120 mg/kg (8 times the maximum recommended human daily oral dose on a mg/m² basis) in rabbits. Similarly, no evidence of animal teratogenicity in rats and rabbits was reported at oral doses up to 96 mg/kg of loratadine alone (approximately 75 and 150 times, respectively, the maximum human daily oral dose on a mg/m² basis). There are, however, no adequate and well-controlled studies in pregnant women. Because animal reproduction studies are not always predictive of human response, CLARITIN-D 24 HOUR Extended Release Tablets should be used during pregnancy only if clearly needed.

Nursing Mothers: It is not known if this combination product is excreted in human milk. However, loratadine when administered alone and its metabolite descarboethoxyloratadine pass easily into breast milk and achieve concentrations that are equivalent to plasma levels, with an AUC_{milk}/AUC_{plasma} ratio of 1.17 and 0.85 for the parent and active metabolite, respectively. Following a single oral dose of 40 mg, a small amount of loratadine and metabolite was excreted into the breast milk (approximately 0.03% of 40 mg over 48 hours). Pseudoephedrine administered alone also distributes into breast milk of the lactating human female. Pseudoephedrine concentrations in milk are consistently higher than those in plasma. The total amount of drug in milk as judged by the area under the curve (AUC) is 2 to 3 times greater than in plasma. The fraction of a pseudoephedrine dose excreted in milk is estimated to be 0.4% to 0.7%. A decision should be made whether to discontinue nursing or to discontinue the drug, taking into account the importance of the drug to the mother. Caution should be exercised when CLARITIN-D 24 HOUR Extended Release Tablets are administered to a nursing woman.

Pediatric Use: Safety and effectiveness in children below the age of 12 years have not been established.

ADVERSE REACTIONS: Information on adverse reactions is provided from placebo-controlled studies involving over 2000 patients, 605 of whom received CLARITIN-D 24 HOUR Extended Release Tablets once daily for up to 2 weeks. In these studies, the incidence of adverse events reported with CLARITIN-D 24 HOUR Extended Release Tablets was similar to those reported with twice-daily (q12h) 120 mg sustained-release pseudoephedrine alone.

REPORTED ADVERSE EVENTS WITH AN INCIDENCE OF ≥2% IN CLARITIN-D 24 HOUR EXTENDED RELEASE TABLETS TREATMENT GROUP IN DOUBLE-BLIND, RANDOMIZED, PLACEBO-CONTROLLED CLINICAL TRIALS

PERCENT OF PATIENTS REPORTING

	CLARITIN-D® 24 HOUR (n = 605)	Loratadine 10 mg (n = 449)	Pseudoephedrine 120 mg q12h (n = 220)	Placebo (n = 605)
Dry Mouth	8	2	7	2
Somnolence	6	4	5	4
Insomnia	5	1	9	1
Pharyngitis	5	5	5	5
Dizziness	4	2	3	2
Coughing	3	2	3	1
Fatigue	3	4	1	2
Nausea	3	2	4	2
Nervousness	3	1	4	1
Anorexia	2	<1	2	0
Dysmenorrhea	2	2	2	1

Adverse events occurring in greater than or equal to 2% of CLARITIN-D 24 HOUR Extended Release Tablets-treated patients, but that were more common in the placebo-treated group, include headache.

Adverse events did not appear to significantly differ based on age, sex, or race, although the number of non-whites was relatively small.

In addition to those adverse events reported above, the following adverse events have been reported in fewer than 2% of patients who received CLARITIN-D 24 HOUR Extended Release Tablets:

Autonomic Nervous System: Altered lacrimation, flushing, increased sweating, mydriasis, thirst.

Body As A Whole: Abnormal vision, asthenia, back pain, chest pain, conjunctivitis, earache, eye pain, facial edema, fever, flu-like symptoms, leg cramps, lymphadenopathy, malaise, rigors, tinnitus.

Cardiovascular System: Hypertension, palpitation, tachycardia.

Central and Peripheral Nervous System: Convulsions, dysphonia, hyperkinesis, hypertonia, migraine, paresthesia, tremor.

Gastrointestinal System: Abdominal distension, altered taste, constipation, diarrhea, dyspepsia, flatulence, gastritis, stomatitis, tongue ulceration, toothache, vomiting.

Liver and Biliary System: Cholelithiasis.

Musculoskeletal System: Arthralgia, musculoskeletal pain, myalgia, tendinitis.

Psychiatric: Agitation, depression, emotional lability, irritability.

Reproductive System: Vaginitis.

Resistance Mechanism: Abscess, viral infection.

Respiratory System: Bronchospasm, dyspnea, epistaxis, hemoptysis, nasal congestion, nasal irritation, pleurisy, pneumonia, sinusitis, sputum increased, wheezing.

Skin and Appendages: Acne, pruritus.

Urinary System: Oliguria, micturition frequency, urinary retention, urinary tract infection.

Additional adverse events reported with the combination of loratadine and pseudoephedrine include abnormal hepatic function, aggressive reaction, anxiety, apathy, confusion, euphoria, paroniria, postural hypotension, syncope, urticaria, vertigo, weight gain.

The following additional adverse events have been reported with CLARITIN Tablets: abdominal distress, alopecia, altered micturition, altered salivation, amnesia, anaphylaxis, angioneurotic edema, blepharospasm, breast enlargement, breast pain, bronchitis, decreased libido, dermatitis, dry hair, dry skin, erythema multiforme, hypoesthesia, impaired concentration, impotence, increased appetite, laryngitis, menorrhagia, nasal dryness, peripheral edema, photosensitivity reaction, purpura, rash, seizures, sneezing, supraventricular tachyarrhythmias, upper respiratory infection, urinary discoloration.

Pseudoephedrine may cause mild CNS stimulation in hypersensitive patients. Nervousness, excitability, restlessness, dizziness, weakness, or insomnia may occur. Headache, drowsiness, tachycardia, palpitation, pressor activity, and cardiac arrhythmias have been reported. Sympathomimetic drugs have also been associated with other untoward effects, such as fear, anxiety, tenseness, tremor, hallucinations, seizures, pallor, respiratory difficulty, dysuria, and cardiovascular collapse.

There have been rare postmarketing reports of mechanical upper gastrointestinal tract obstruction in patients taking CLARITIN-D 24 HOUR Extended Release Tablets. In many of these cases, patients have had a history of difficulty in swallowing tablets or have had known upper gastrointestinal narrowing or abnormal esophageal peristalsis.

OVERDOSAGE: In the event of overdosage, general symptomatic and supportive measures should be instituted promptly and maintained for as long as necessary. Treatment of overdosage would reasonably consist of emesis (ipecac syrup), except in patients with impaired consciousness, followed by the administration of activated charcoal to absorb any remaining drug. If vomiting is unsuccessful, or contraindicated, gastric lavage should be performed with normal saline. Saline cathartics may also be of value for rapid dilution of bowel contents. Loratadine is not eliminated by hemodialysis. It is not known if loratadine is eliminated by peritoneal dialysis.

Somnolence, tachycardia, and headache have been reported with doses of 40 to 180 mg of loratadine. In large doses, sympathomimetics may give rise to giddiness, headache, nausea, vomiting, sweating, thirst, tachycardia, precordial pain, palpitations, difficulty in micturition, muscular weakness and tenseness, anxiety, restlessness, and insomnia. Many patients can present a toxic psychosis with delusions and hallucinations. Some may develop cardiac arrhythmias, circulatory collapse, convulsions, coma, and respiratory failure.

The oral median lethal dose for the mixture of the two drugs was greater than 525 and 1839 mg/kg in mice and rats, respectively (approximately 10 and 58 times the maximum recommended human daily oral dose on a mg/m² basis). The oral median lethal dose for loratadine was greater than 5000 mg/kg in rats and mice (greater than 2000 times the maximum recommended human daily oral dose on a mg/m² basis). Single oral doses of loratadine showed no effects in rats, mice, and monkeys at doses as high as 10 times the maximum recommended human daily oral dose on a mg/m² basis.

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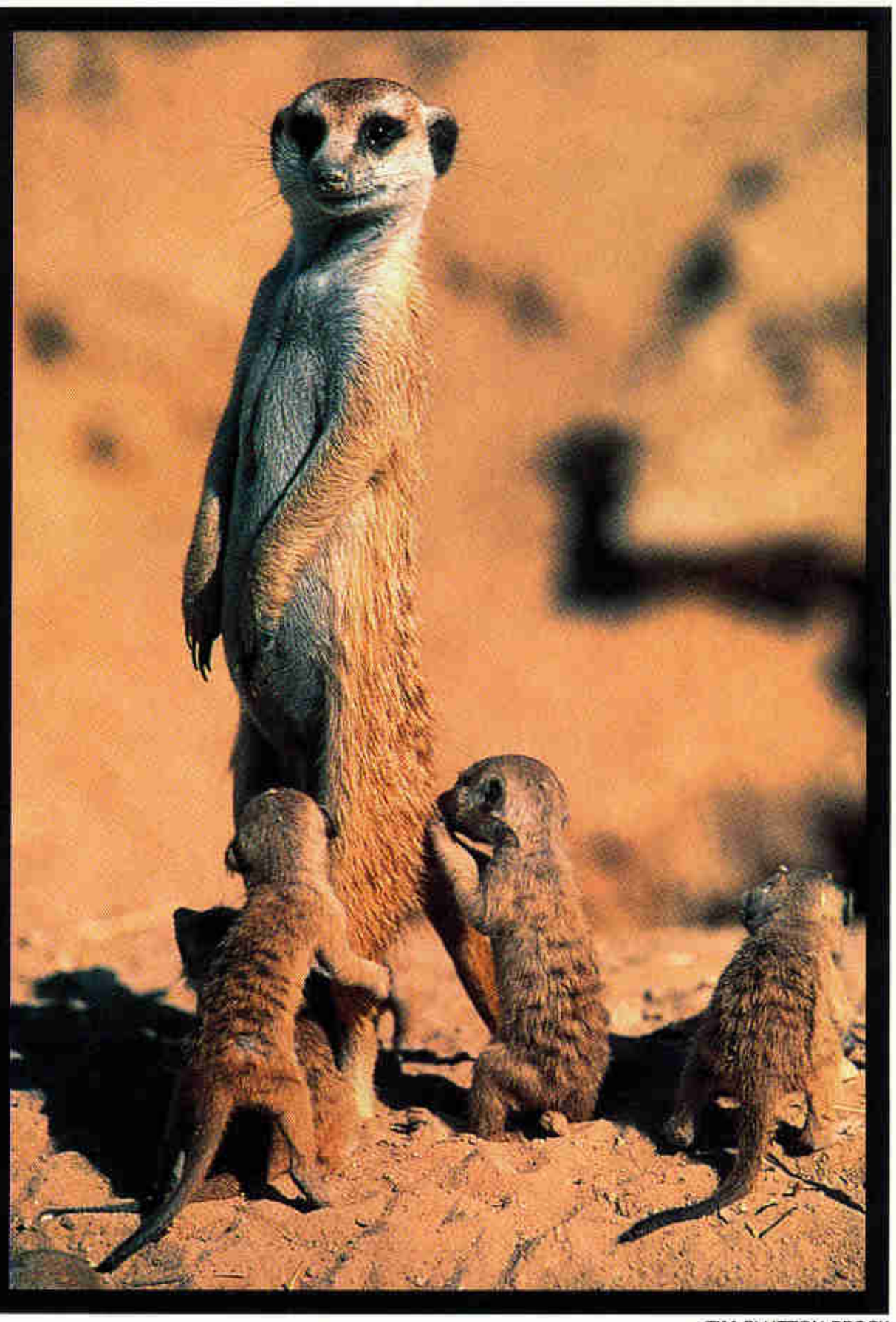
NATIONAL GEOGRAPHIC

Earth Almanac

Are Hungry Mongoose Babysitters Rewarded?

Small mongooses called suricates, or meerkats, band together in groups of 3 to 25 animals for mutual survival in southern Africa's Kalahari Desert. They seem to have rules for everything, such as which members can breed and which can't. Suricates that don't breed often serve as babysitters for the successful breeders' pups. While the parents go hunting for insects and small vertebrates, the babysitters guard the little ones from birds of prey and jackals.

Since these helpers can't forage, they lose a lot of weight, according to biologist Tim Clutton-Brock and his colleagues at the Universities of Cambridge and Pretoria. They seek to unravel an evolutionary mystery: Since the babysitters pay such a great price, do they receive hidden benefits for their altruism from the rest of suricate society?



TIM CLUTTON-BROCK

Endangered Species Rally





BOTH BY KEN KIMBALL, APPALACHIAN MOUNTAIN CLUB

A helping hand from conservationists can make a difference for imperiled animals and plants. Last May the U.S. Fish and Wildlife Service announced that 30 species had recovered enough that, over the next two years, it plans to downgrade them from endangered to threatened or remove them from the list altogether. The good news affects the gray wolf, bald eagle, peregrine falcon, and "a tough little plant" called Robbins' cinquefoil (above), says one of its champions, Ken Kimball, botanist and director of research for the Appalachian Mountain Club. Mainly found on a 1.5-acre site in New Hampshire's White Mountains, the plant was declared endangered in 1980. Two local hiking trails were then relocated. The New England Wild Flower Society propagates the plants in a nursery, and they are then transplanted to nearby sites (above).



G. RYAN, GREAT BARRIER REEF MARINE PARK AUTHORITY

Refuges for Australia's Dugongs

Saltwater cousins of manatees, at least 85,000 dugongs swim off Australia, including this one near the Great Barrier Reef. But dugongs on the reef's southern end are in trouble, reduced from some 3,600 to about 1,600 since 1987. The animals drown in commercial gill nets and antishark nets, and coastline development has destroyed sea grass beds they feed on.

Dugong protection has been beefed up, with 15 new sanctuaries totaling 1,795 square miles established along the southern reef. In them gillnetting has been restricted or banned.

Hunting Prowess From Plants

Secret weapons from nature enhance the bows and arrows of the Matsigenka (Machiguenga) people living in Peru's Manu National Park. To focus their aim and improve their concentration, men cultivate varieties of sedges like this one as hunting medicines, which they call *ivenkiki.* White growths are a fungus that kills the sedges' fruits and flowers but not the bulb—crucial to the hunters. The fungus infuses the bulb with an alkaloid that when chewed acts as a physical and mental stimulant.



MARK W. MOFFETT

Men use different sedges when hunting different prey—spider monkeys, woolly monkeys, tapirs, or fish. Although the chewed root is not poisonous, men may also rub it on their arrows, believing it improves their shots.

Anthropologist Glenn Shepard, Jr., who has studied the Matsigenka for 12 years, once gained a temporary talent from a sedge. To amuse villagers, he had long tried to juggle fruit but couldn't learn the trick. When the sedge stimulant took effect, "It improved my concentration in some subtle way, and suddenly I realized, Wow, I'm juggling!" Shepard says.

Men also use sedge liquid as eyedrops to improve their vision. They give other plants to their dogs to sharpen tracking skills. Matsigenka women have their own apothecary of about 50 species of plants used in caring for newborn infants. In all, Matsigenka use more than 270 medicinal plants.

TEXT BY JOHN L. ELIOT

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KAREN KASMAUSKI

■ Today's children (above) face a world more crowded and complicated than ever before. View a selection of stunning images and ponder insights from the authors of this issue's millennium articles on population at *www.nationalgeographic.com/features/2000/population.*

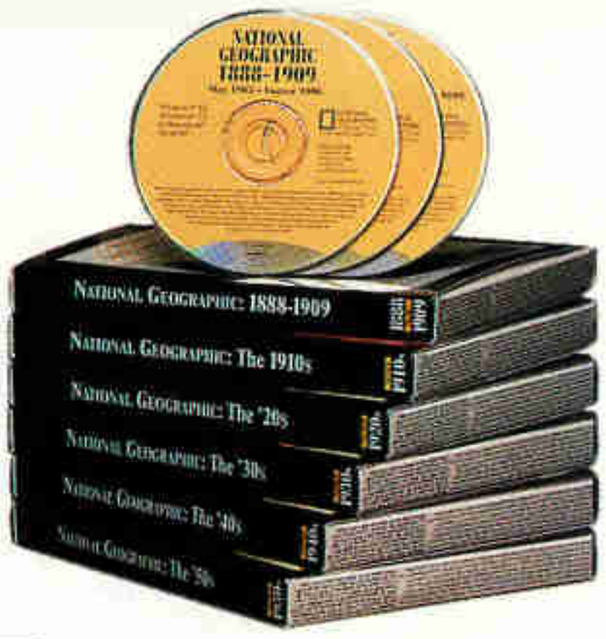
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NATIONAL GEOGRAPHIC

On Assignment



KAREN KASMAUSKI

■ WOMEN AND POPULATION

She's Connected

"They wanted to know as much about me as I did about them," says freelance photographer Karen Kasmauski (above, with camera) of the aspiring entrepreneurs she met in Dhaka, Bangladesh. The women had recently received bank loans to purchase cellular telephones, which fellow villagers pay to use. Doing double duty for this issue—Karen also covered the human migration story—she visited nine countries over four months. Everywhere she went, she felt a kinship with the women she photographed. "Even though our lives are very different, I'm a wife and mother too," she says. Population, of course, is not simply a women's issue. "It's everybody's issue," says Karen. "It takes two people to start a family."



DAVE MARCHANT

■ ANTARCTIC DESERT

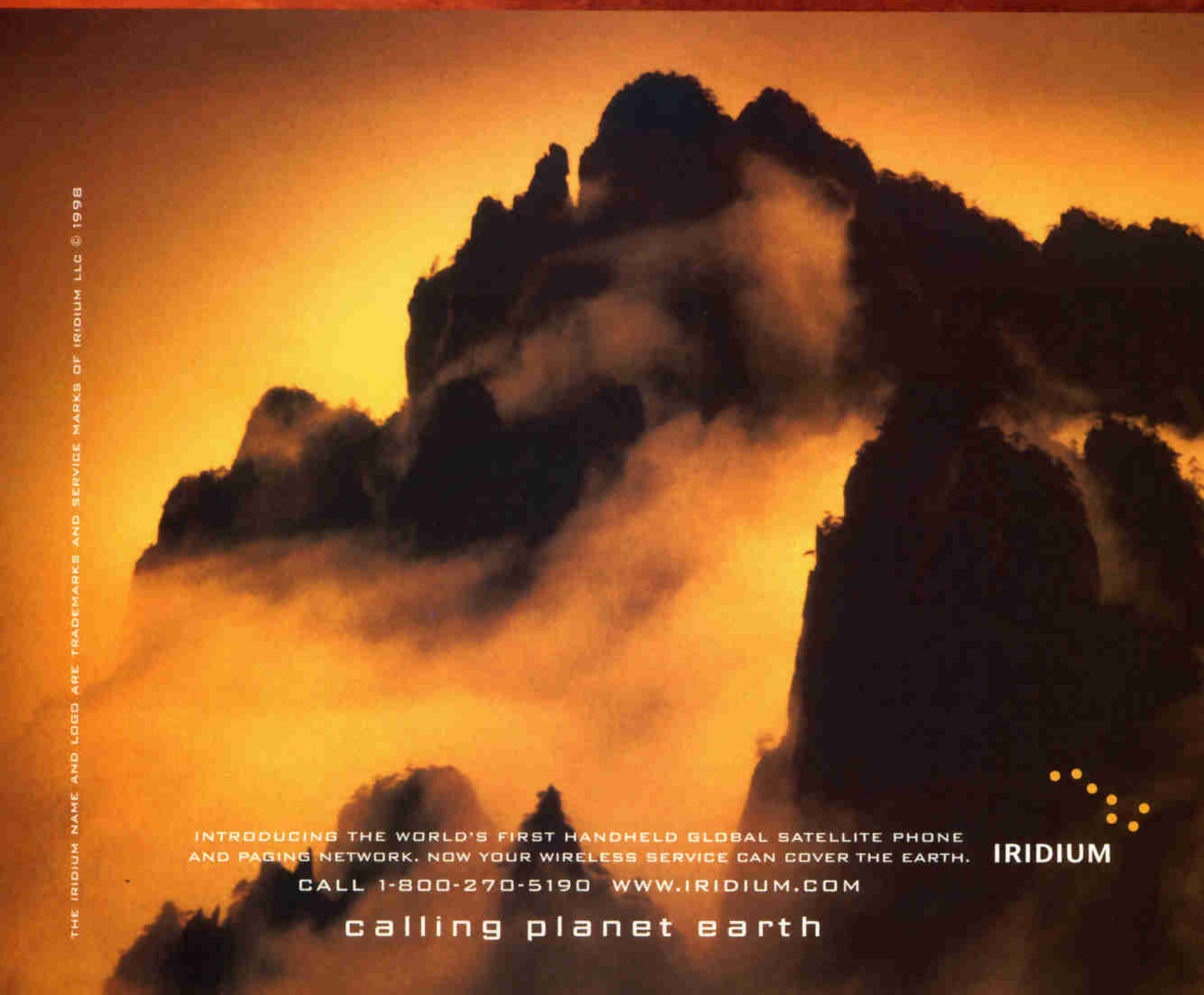
Song of the South Pole

No carols rang from the tents last Christmas Eve at Cirque 6 in Antarctica. "We played Motown instead," recalls photographer Maria Stenzel, at center, grooving with grad students Beth Hartman and Sarah Mills. Next morning, "we all got comic books as gifts, but then we had to give them back. They've reused the same comics for 12 years." Outdoor stories like this one are Maria's favorites to shoot. "I never wanted to camp much as a kid," she says. "I guess I'm having my childhood now."

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